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NAVORD REPORT 6772

WIND TUNNEL INVESTIGATION OF THE MK 76 PRACTICE BOMB

11 SEPTEMBER 1964

U. S. NAVAL ORDNANCE LABORATORY

WHITE OAK, MARYLAND

NAVORD REPORT 6772

Aerodynamic Research Report 79

WIND TUNNEL INVESTIGATION OF THE MK 76 PRACTICE BOMB

Prepared by:
Frank J. Regan

ABSTRACT: The MK 76 is a 25 pound, 4 inch diameter Practice Bomb used in large quantities by the U. S. Navy and Air Force. This report gives the results of the static and dynamic wind tunnel tests of the basic body with various combinations of fuzes, lugs and tails.

Originally, the configuration consisted of the basic body with a shrouded cruciform tail. This bomb had an impact fuze and a carrying lug. The effect of the presence of this fuze and lug on the bomb's normal force and pitching moment were investigated in the Mach number range between 0.29 and 1.75. The effect of moving the tail aft slightly was also investigated. The results of these tests indicated a center of pressure 3.2 calibers aft of the nose. Moving the tail aft brought the center of pressure aft to a point 3.8 calibers from the nose.

It was then decided to replace the shrouded tail by two tails of unshrouded design. The first of these was a cruciform tail with a swept leading edge. The basic body was tested with this tail in three positions. The result was a center of pressure location 4.0 calibers aft of the nose, for the forward position of the tail, to 4.5 calibers aft of the nose, for the aft position of the tail. Finally, a cruciform tail of rectangular fins was tested. The result was a center of pressure location of about 4.6 calibers aft of the nose.

Pitch damping tests were carried out on the bomb with both the cruciform swept and cruciform rectangular tails. Drag measurements were made of the bomb with both the shroud and cruciform rectangular tails with combinations of lugs and fuzes.

PUBLISHED NOVEMBER 1964
U. S. NAVAL ORDNANCE LABORATORY
White Oak, Silver Spring, Maryland

NAVORD REPORT 6772 11 September 1964

WIND TUNNEL INVESTIGATION OF THE MK 76 PRACTICE BOMB

The purpose of this investigation was to obtain the static stability (normal force and pitching moment), drag and pitch damping moment data for the MK 76 Practice Bomb.

This project was performed at the request of the Bureau of Naval Weapons under Task Number RMMO 42-005/212-1/F008-09-01.

The author wishes to acknowledge the assistance rendered by Mr. P. Ceretta in data acquisition, Miss M. E. Falusi in data reduction and compilation, and Miss A. Evans in report preparation.

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K. R. ENKENHUS
By direction

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INTRODUCTION

The MK 76 is a 25 pound, 4 inch diameter Practice Bomb used in large quantities by the U. S. Navy and Air Force. This report gives the results of the static and dynamic wind tunnel tests of the basic body with various combinations of fuzes, lugs and tails.

SYMBOLS

A	reference area, $\pi d^2/4$
C_{D_o}	drag force coefficient at zero degrees angle of attack, D/QAd
C_m	static pitching moment coefficient, M_y/QAd
C_{m_α}	derivative of the static pitching moment coefficient with respect to α
$C_{m_q} + C_{m_{\dot{\alpha}}}$	pitch damping coefficient, $(2V/QAd)(\partial M_y/\partial q + \partial M_y/\partial \dot{\alpha})$
C_N	normal force coefficient, N/QA
C_{N_α}	derivative of the normal force coefficient with respect to α
d	maximum body length (2.4 in)
D	drag force
I_{yy}	transverse moment of inertia (about y axis)
ℓ	body length
M	Mach number
M_y	pitching moment (about y axis)
N	normal force
Q	dynamic pressure
q	pitch rate
t	time
V	airspeed

y axis normal to bomb's longitudinal axis and in a plane defined by opposing tail fins

α angle of attack

$\bar{\alpha}$ envelope of plotted pitch damping data

ρ air density

NOMENCLATURE

B body

F^1 impact fuze (AN-M146 MTF)

F^2 air burst fuze (XB-125A)

L body lug

T^1_1 shroud tail in forward position (ℓ = 13.54 inches)

T^1_2 shroud tail in aft position (ℓ = 14.29 inches)

T^2_1 cruciform-swept tail in forward position (ℓ = 13.542 inches)

T^2_2 cruciform-swept tail in mid position (ℓ = 14.29 inches)

T^2_3 cruciform-swept tail in aft position (ℓ = 15.04 inches)

T_3 cruciform-rectangular tail (ℓ = 15.04 inches)

DESCRIPTION OF BOMB CONFIGURATIONS

Table 1 lists the various configurations of the MK 76 Practice Bomb that were tested. Figures 1 through 4 are photographs of all body-tail configurations tested. Figures 5 through 10 are detail drawings of the tails, lugs and fuzes.

All models used in the static tests were 0.6 scale. Since the bomb is 4.0 inches in diameter the wind tunnel models for the static tests were 2.4 inches in diameter.

For brevity all configurations have been represented symbolically by a code which designates the body, lug, fuze, tail and tail position. Combining the symbols listed in the nomenclature, it is possible to represent any configuration by

a code designation. Thus, the shrouded-tail is represented by the superscript ^{1} in the symbol T^1_j. The subscript j takes on the value 1 or 2 to designate the forward or aft position of the tail. When the shrouded-tail is in the forward or aft position the corresponding body length is 13.54 or 14.29 inches, respectively. The swept cruciform and rectangular cruciform tails are represented by the symbols T^2 and T^3. The swept cruciform tail was tested in three positions: forward, mid and aft. The corresponding body lengths are 13.54, 14.29 and 15.04 inches, respectively. The symbol T^2_j is used with the subscript j taking on the values 1, 2 and 3 to designate the forward, mid and aft positions. The tail T^3 was only tested in one position (with a body of length 15.04 inches). For this reason, no subscript is used. Drawings of tails T^1, T^2 and T^3 are given in Figures 6, 7 and 8, respectively.

Bombs were tested with a mounting lug and two different fuzes. The lug is represented by the symbol L, and the fuzes by F^1 for the impact fuze and F^2 for the airburst fuze. The absence of L and F indicates that the bomb was tested without that component. Figures 9 and 10 are drawings of the lug and fuzes, respectively.

In the plotted data (Figures 11 through 44) the above code convention has been used to designate the lug, fuze, tail and tail position, where appropriate. Representative configurations have been given in Figures 1 through 4. The codes for these figures are: $BLF^1T^1_1$, $BLF^1T^1_2$, $BLF^1T^2_3$ and BLF^2T^3, respectively.

TEST TECHNIQUE

The wind tunnel tests were carried out in Supersonic Tunnel Number 1. Force and moment data were obtained using a multiple-component internal strain-gage balance. The free oscillation technique was used in the pitch damping tests. The pitch damping model was dynamically balanced about the full scale center of gravity. The model was mounted by means of internal ball bearings to a transverse rod through the center of gravity. Except for a negligible amount of bearing torque the model has complete freedom in pitch.

The pitch damping test technique was as follows: Tunnel flow was established with the model in a non-trimmed condition. From this initial trim displacement the model under-

went a series of pitch damping oscillations of decreasing amplitude. This oscillatory motion was recorded with a 16 mm movie film speed of 64 frames per second.

DATA REDUCTION

The static wind tunnel data were recorded on IBM cards using the automatic recording system described in reference (2). Using the equations in reference (3), these data were reduced to coefficient form on an IBM 650 digital computer. The data have been corrected for the elastic deflection of the sting support caused by aerodynamic loading.

The moment reference center was taken to be the center of gravity of each wind tunnel model. Table 2 gives the center of gravity location from the nose of the model. The nose of the bomb proper, exclusive of any fuzes present, is the reference point from which the center of gravity and center of pressure are measured.

The pitch damping data reduction method is described in detail in reference (4). Briefly, the method consists of two parts: reading the film and fitting an envelope to the plotted film data. The angle of attack of the model was measured from each frame of film. A time record was obtained from a knowledge of the film speed. A plot of the angular deflection of the model versus time resulted in a damped sinusoidal curve. The logarithmic decrement of the envelope of this curve gave, after non-dimensionalizing the measured quantities, the pitch damping coefficient, $C_{m_q} + C_{m_{\dot{\alpha}}}$. The equation of motion of the unconstrained pitch oscillations is, in coefficient form,

$$\ddot{\alpha} - \frac{(C_{m_q} + C_{m_{\dot{\alpha}}})QAd^2\dot{\alpha}}{2VI_{yy}} - \frac{C_{m_\alpha} QAd}{I_{yy}} \alpha = 0 \qquad (1)$$

which has as an approximate solution for the case of light damping:

$$\alpha = \bar{\alpha}\mathrm{Cos}\left\{ \sqrt{\frac{-C_{m_\alpha} QAd}{I_{yy}}}\; t \right\} \qquad (2)$$

The quantity $\bar{\alpha}$ is an analytic expression for the envelope of the plotted pitch damping data. For the case of linear damping this is given by the following expression:

$$\bar{\alpha} = \alpha_{o\rho} \left(\frac{(C_{m_q} + C_{m_{\dot{\alpha}}})QAd^2}{4VI_{yy}} \right) t \tag{3}$$

where α_o is the pitch angle at an arbitrarily selected initial time. Thus, for two points on the envelope, $\bar{\alpha}(t)$ and α_o, separated in time by t seconds, equation (3) may be solved for the pitch damping coefficient, $C_{m_q} + C_{m_{\dot{\alpha}}}$. The result is an expression containing only known or measurable quantities.

RESULTS AND DISCUSSION

Table 1 lists the configurations tested and provides an index to the graphical presentation of wind tunnel results. The static data are presented in Figures 11 through 41. These data are the normal force coefficient, C_N, and the pitching moment coefficient, C_m, versus angle of attack, α. The drag measurements are given in Figures 42 and 43 as drag coefficient at zero degrees angle of attack, C_{D_o}, versus Mach number. The results of the pitch damping tests are given in Figure 44 as the pitch damping coefficient, $C_{m_q} + C_{m_{\dot{\alpha}}}$ versus Mach number. These data will now be examined in order to recommend a configuration.

It will be noted in Table 1 that the most comprehensive static wind tunnel data were obtained using the basic body, B, the lug L, the impact fuze, F^1, and the shrouded tail in the forward position, T^1_1. These components were combined into configurations BT^1_1, BLT^1_1, $BF^1T^1_1$, and $BLF^1T^1_1$. These were tested at Mach numbers of 0.29, 0.42, 0.50 and 0.59. Data were also obtained on the BLT^1_1 and $BLF^1T^1_1$ configurations at Mach numbers of 0.72, 0.85 and 1.75.

A comparative analysis of the various configurations must involve assessing the relative influence of lugs, fuzes, tail design and tail position. Table 2 was prepared to facilitate this comparison. It presents the center of pressure (in calibers) from the nose for the four configurations at a Mach number of 0.59.

There are certain features of these data that should be emphasized. It will be noted that the addition of a lug moves the center of pressure slightly rearward. The addition of a nose fuze, on the other hand, moves the center of pressure forward. Moving the tail rearward about 0.3 calibers moves the center of pressure rearward about 0.6 calibers.

A limited amount of wind tunnel data was taken using the cruciform swept tail, T^2, and the cruciform rectangular tail, T^3. Table 2 gives the center of pressure of the two unshrouded tails and the shrouded tail. The shrouded tail, T^1, and the cruciform swept tail, T^2, can be compared using configurations BLT^1_1 and BLT^2_1. This comparison shows that with the same body length the cruciform swept tail, T^2, has a center of pressure location further aft than the shrouded tail, T^1_1. A similar conclusion is reached in comparing configurations BLT^1_2, $BLF^1T^1_2$ with configurations BLT^2_2, $BLF^1T^2_2$.

The T^2 tail was tested in a third position. It can be seen that moving the tail about 0.3 calibers further aft results in a rearward displacement of the center of pressure of about 0.5 calibers. It should be noted in passing that as in the case of the T^1 tail the presence of the fuze moves the center of pressure forward.

Finally, a series of tests were conducted of the T^3 tail in a position corresponding to a body length of 6.267 calibers. This is the same body length as when the T^2_3 tail was used. Since no tests were conducted on the shrouded tail, T^1, in this position, direct comparison may be made only between the T^2_3 and T^3 tails. In spite of the fact that these tails cannot be compared at the same Mach number, it is obvious that the T^3 tail is superior to the T^2_3 tail, as far as static test results are concerned. Therefore, it was decided to compare the

effectiveness of the cruciform swept tail, T^2_s, and the cruciform rectangular tail, T^3, in pitch damping. The results of these pitch damping tests are given in Figure 44 as a comparison of configurations BLF^1T^3, BT^3 and BT^2_s. It is evident that, while all configurations are similar in pitch damping, the configurations using the cruciform rectangular tail, T^3, are superior to the configuration using the cruciform swept tail, T^2. The presence of the fuze increases the pitch damping coefficient.

A series of drag tests were also conducted on configurations using the shrouded tail, T^1, and the cruciform rectangular tail, T^3. The results are presented in Figures 42 and 43, respectively. In examining these figures, it can be seen that the presence of lugs increases drag and that the impact fuze, F^1, results in a higher configurational drag than does the airburst fuze, F^2.

CONCLUSIONS

The nonshrouded tails, T^2 and T^3, give a further aft location of the center of pressure than does the shrouded tail, T^1. Of these nonshrouded tails, the cruciform rectangular tail, T^3, is superior both statically and dynamically.

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(2) Gilbert, B. D., "Automatic Data Processing System (ADAPS) for the Supersonic Wind Tunnels," NAVORD Rpt 2813 (1953)

(3) Shantz, I., Gilbert, B. D., and White, C. E., "NOL Wind Tunnel Internal Strain-Gage Balance System," NAVORD Rpt 2972 (1953)

(4) Shantz, I., and Groves, R. T., "Damping and Static Stability in Pitch Measurements of the Ten Caliber Basic Finner at Supersonic Speeds," NAVORD Rpt 4516 (1960)

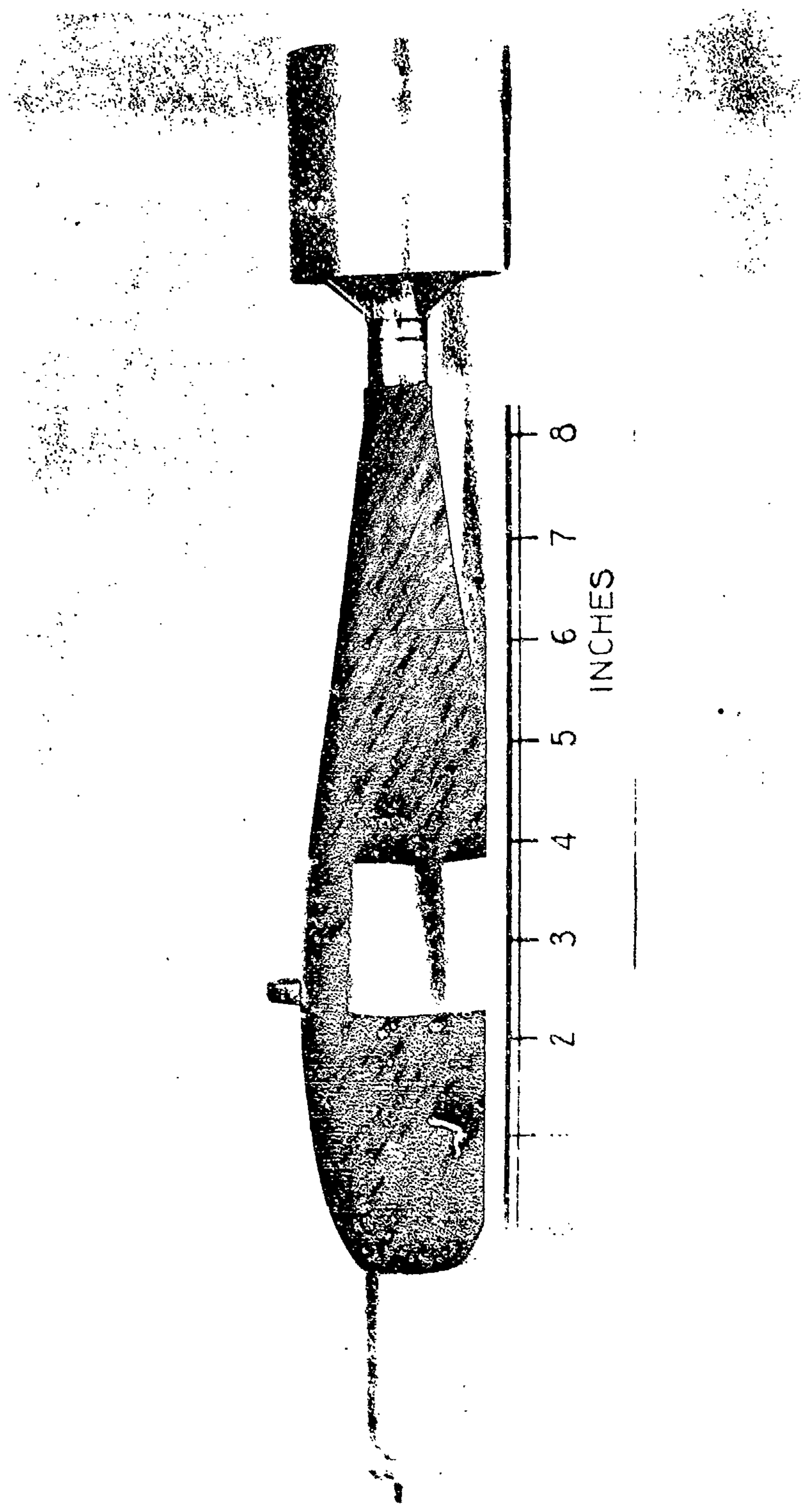

FIG.1 MK 76 PRACTICE BOMB WITH IMPACT FUZE AND SHROUD TAIL
IN FORWARD POSITION

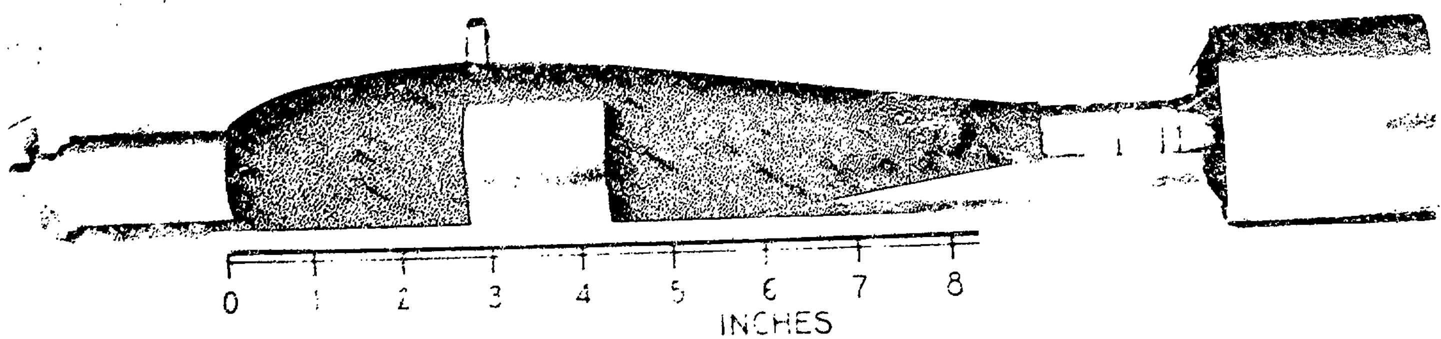

FIG. 2 MK 76 PRACTICE BOMB WITH IMPACT FUZE AND SHROUD TAIL IN AFT POSITION

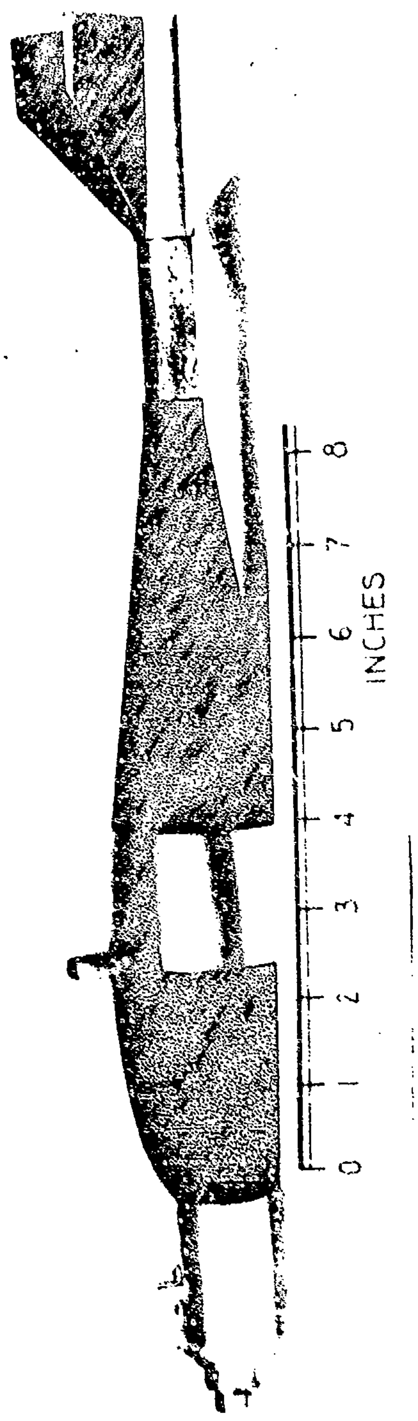

FIG. 3 MK 76 PRACTICE BOMB WITH IMPACT FUZE AND CRUCIFORM-SWEPT TAIL IN AFT POSITION

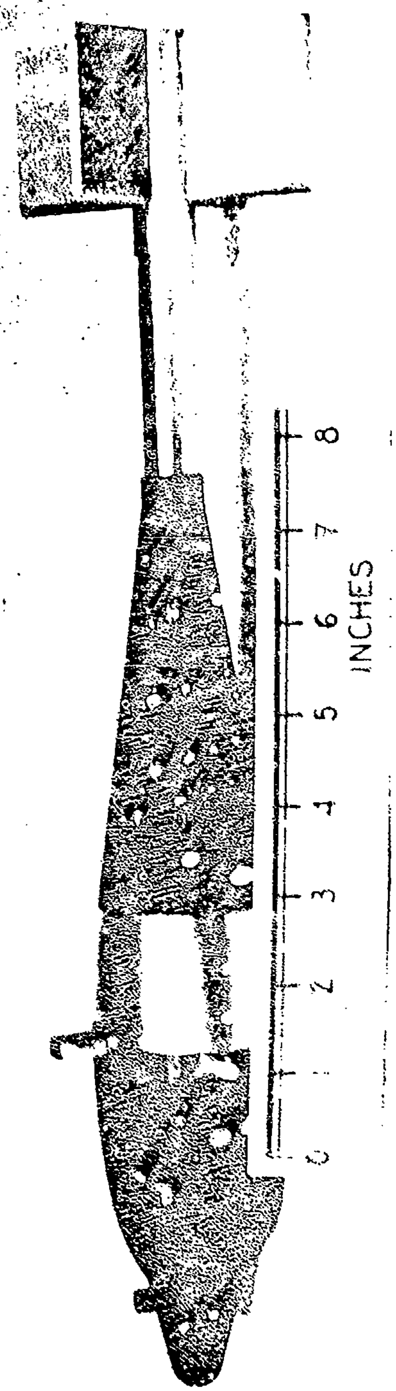

FIG.4 MK 76 PRACTICE BOMB WITH AIRBURST FUZE AND CRUCIFORM-RECTANGULAR TAIL

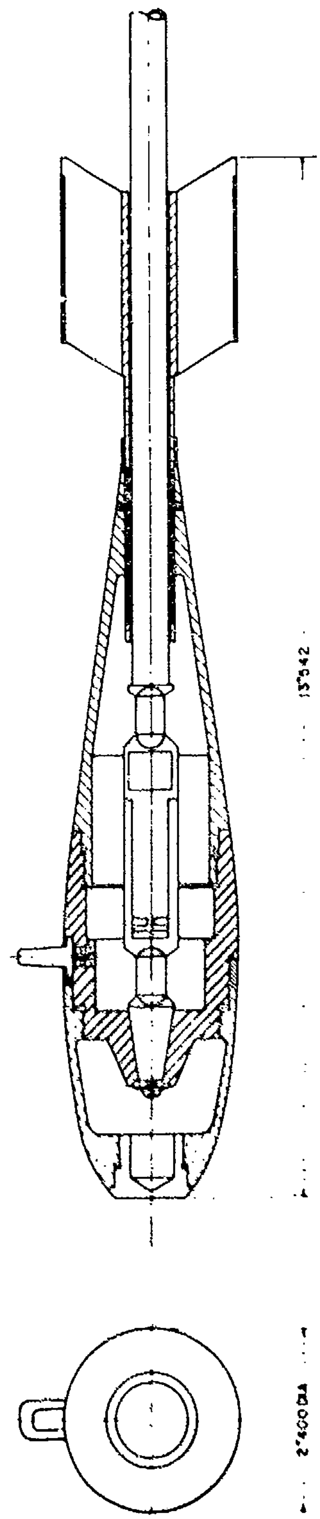

FIG. 5 MK 76 PRACTICE BOMB WITH SHROUD TAIL IN FORWARD POSITION

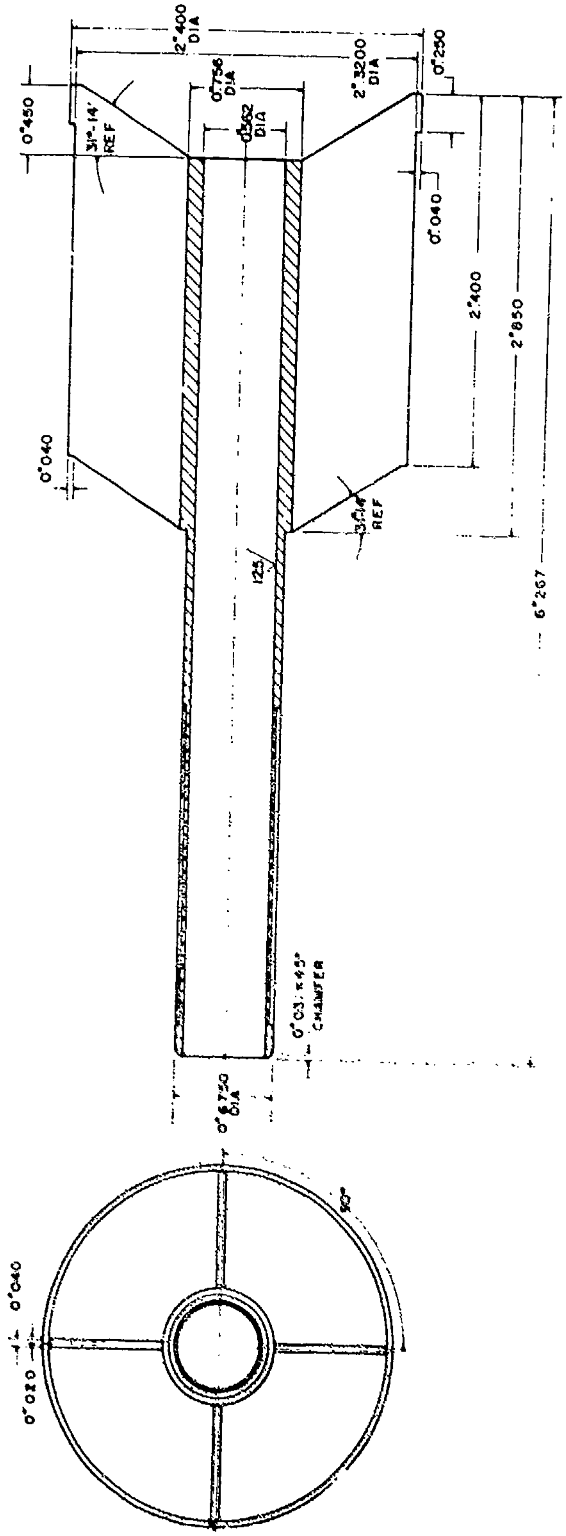

FIG. 6 SHROUD TAIL FOR THE MK 76 PRACTICE BOMB

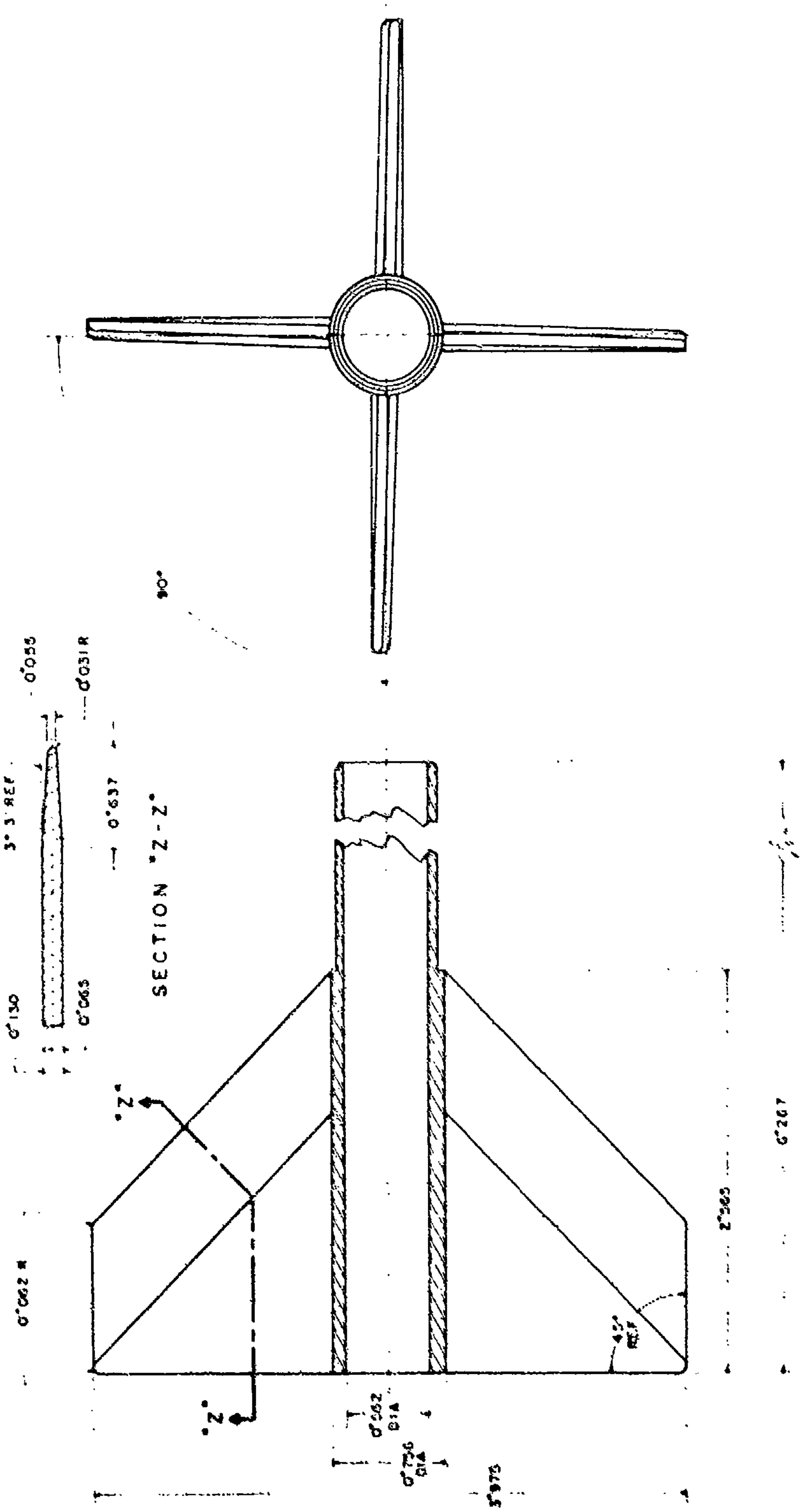

FIG. 7 CRUCIFORM - SWEPT TAIL FOR MK 76 PRACTICE BOMB

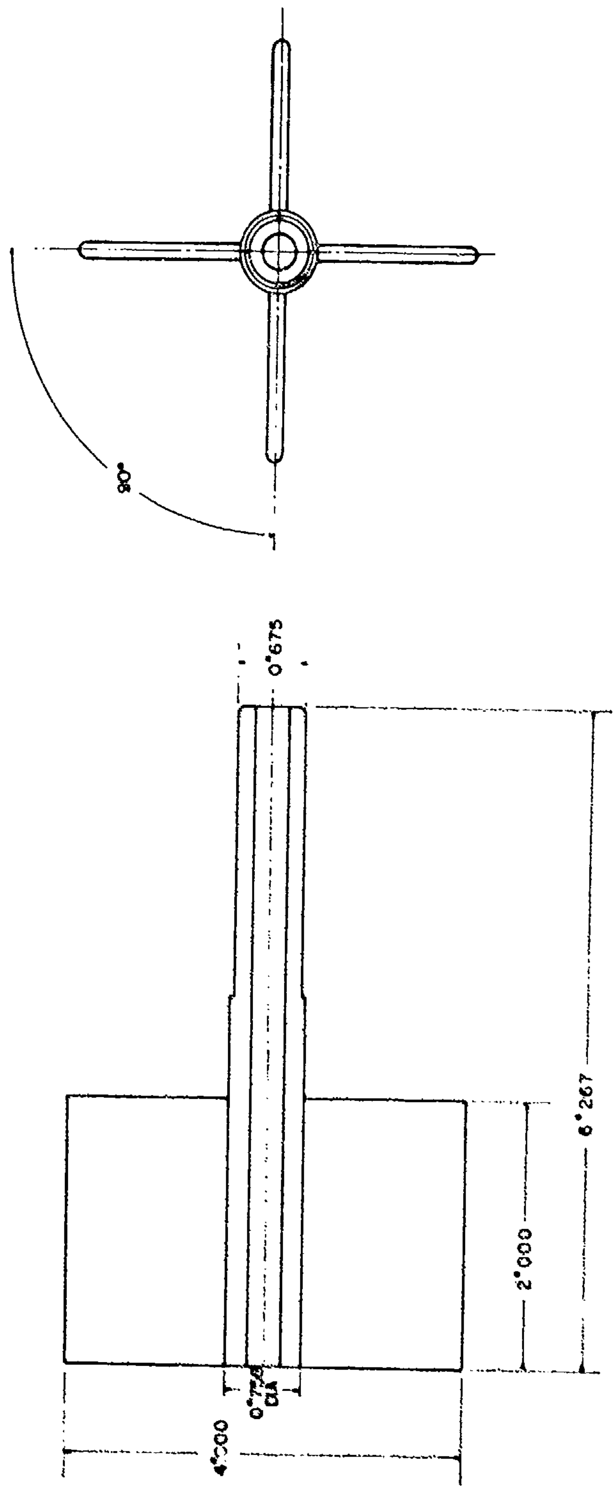

FIG. 8 CRUCIFORM - RECTANGULAR TAIL FOR MK 76 PRACTICE BOMB

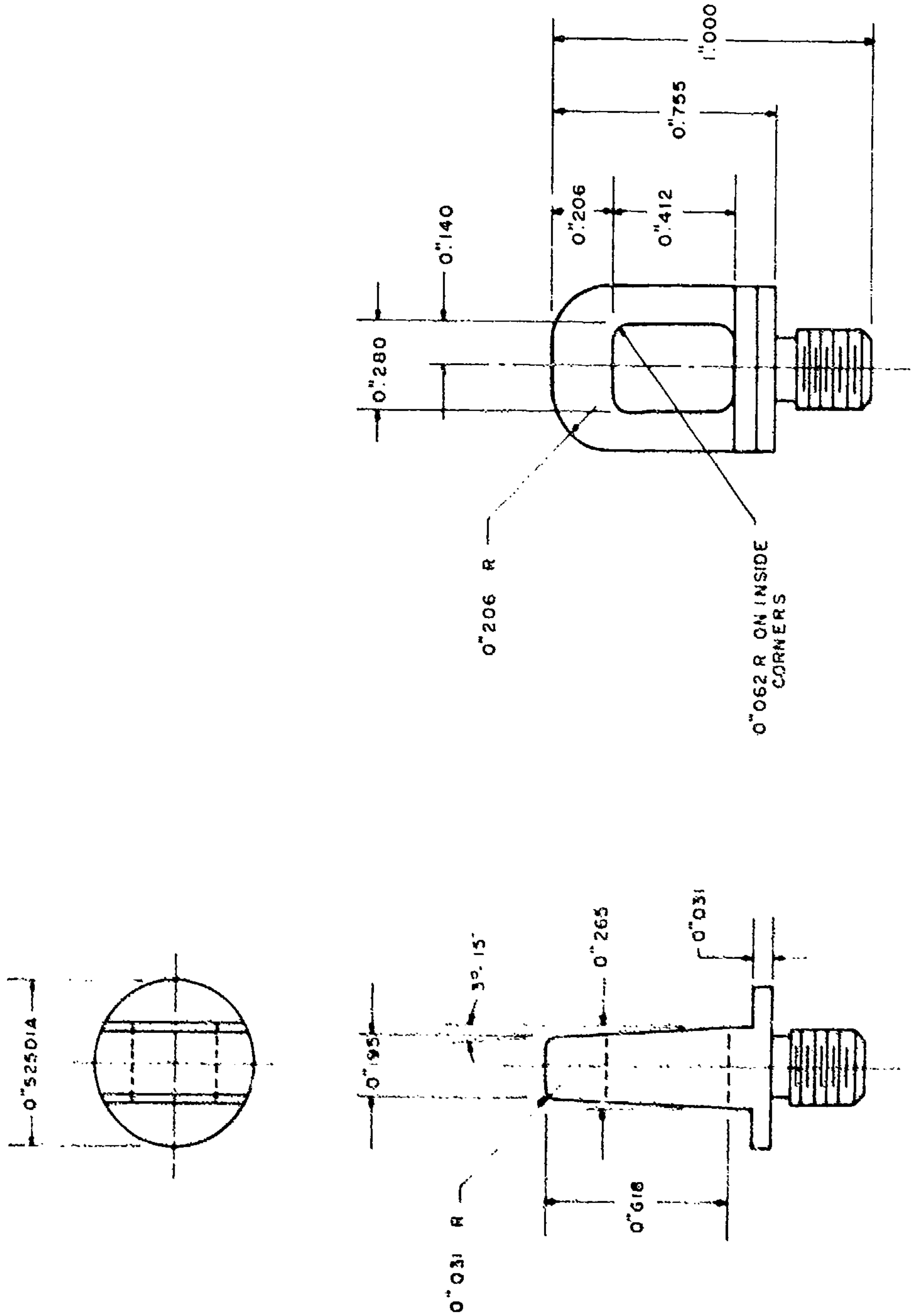

FIG 9 LUG FOR MK 76 PRACTICE BOMB

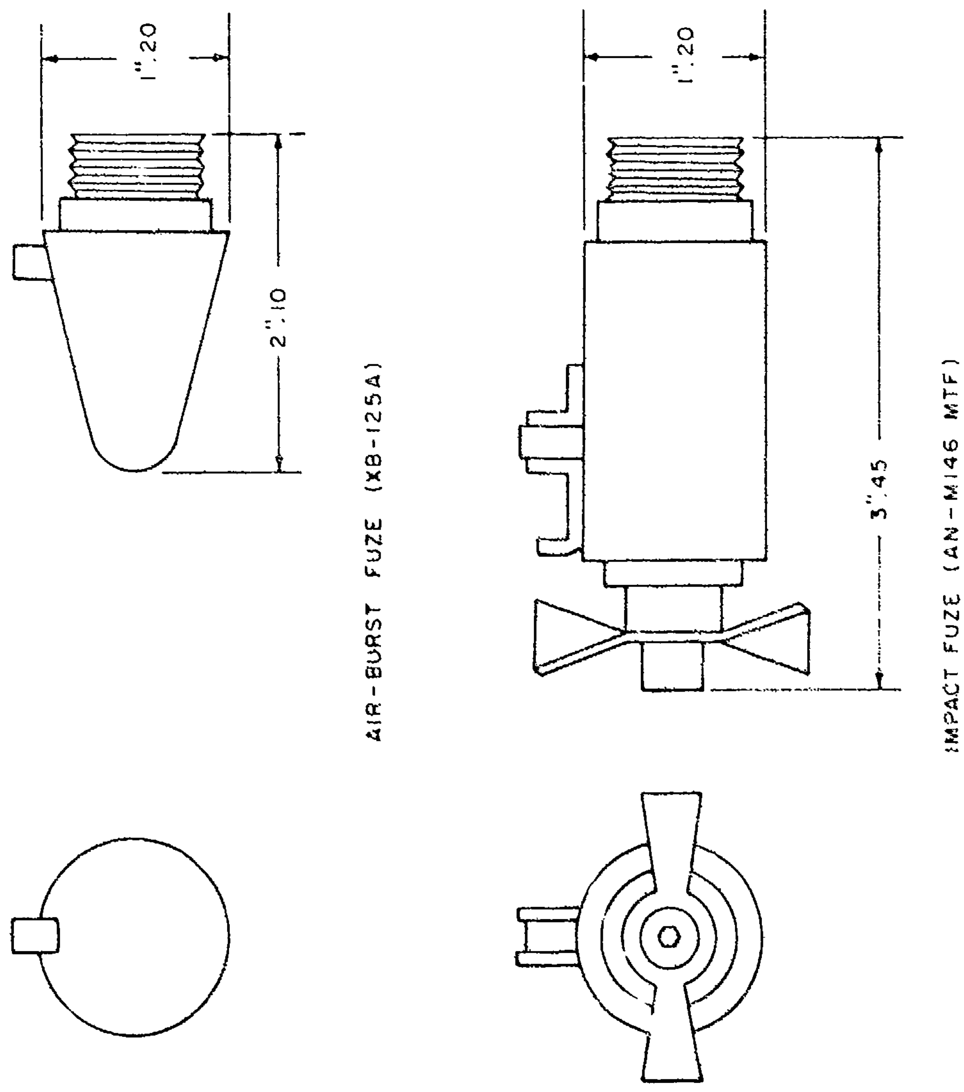

FIG. 10 FUZE DESIGNS USED WITH MK 76 PRACTICE BOMB

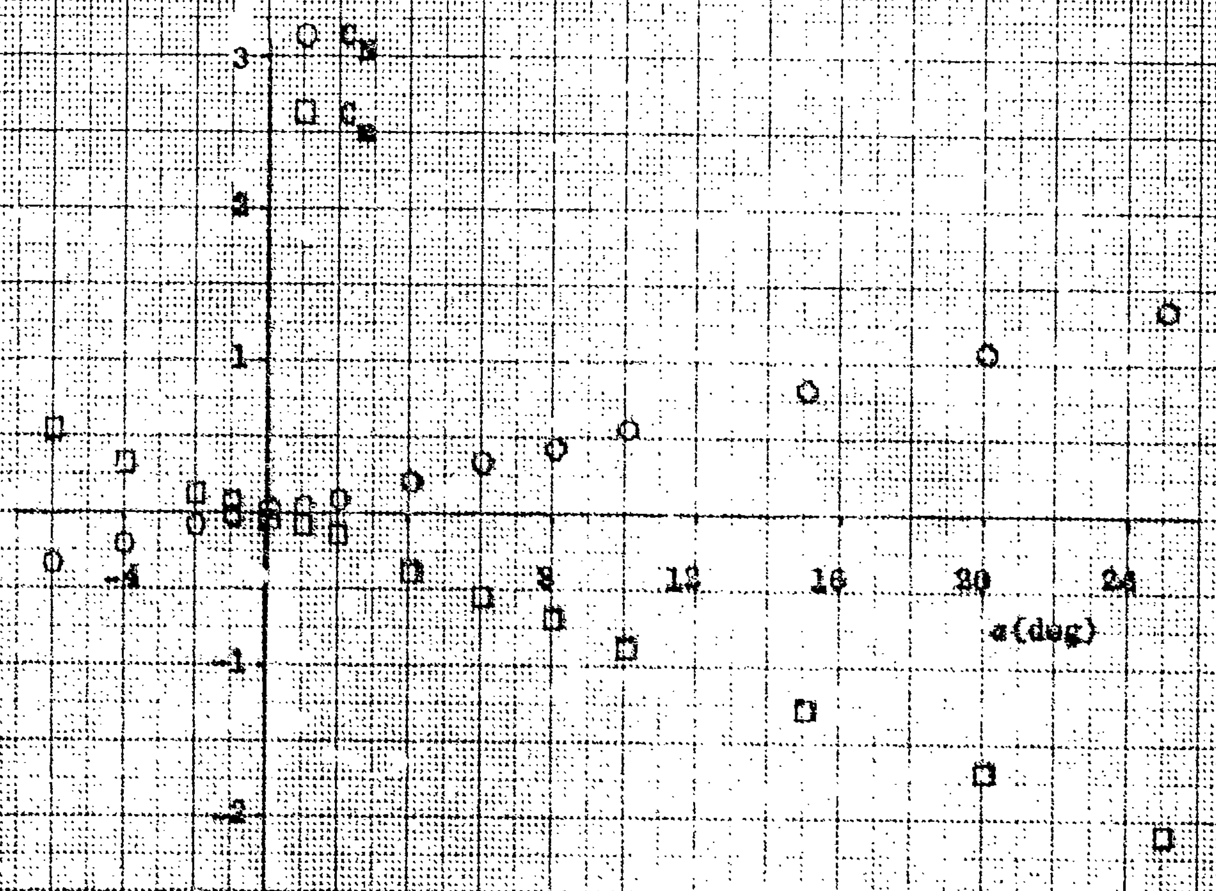

FIG. 11 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BT_1^2 AT MACH NUMBER 0.29

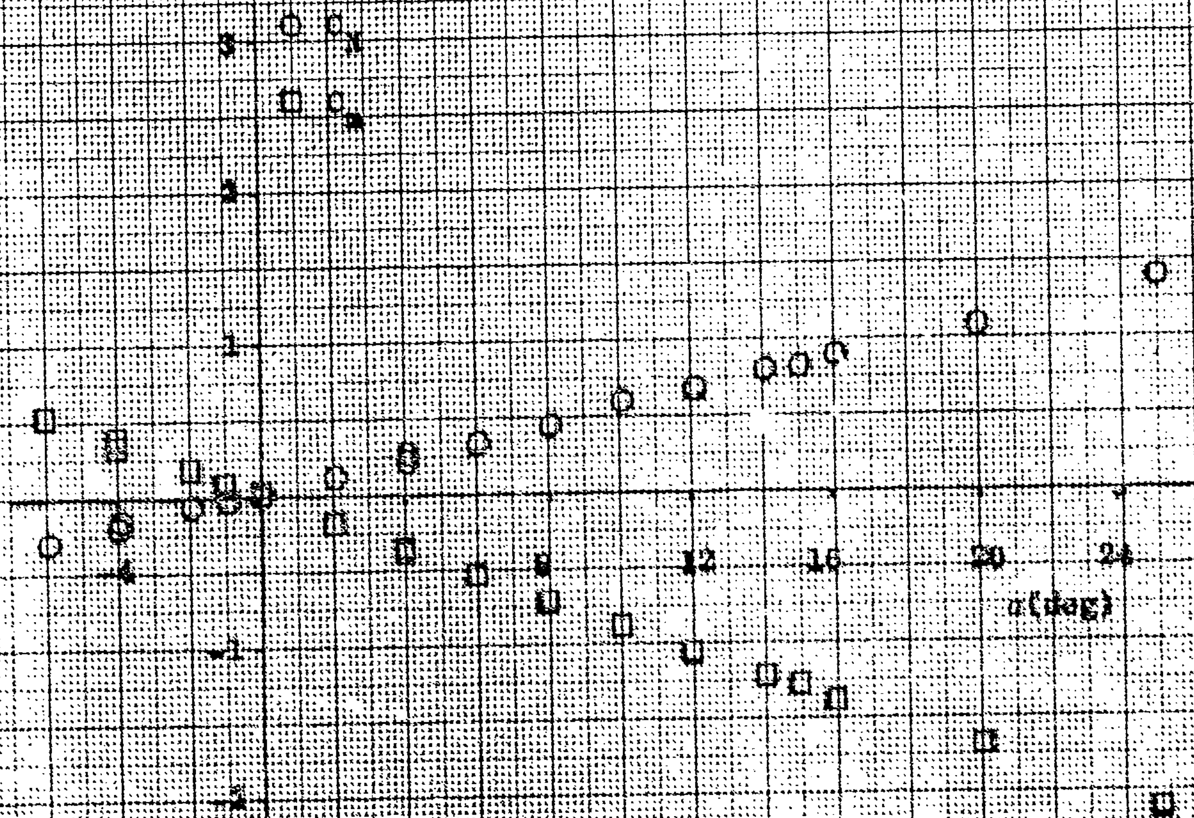

FIG. 12 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLT_1^2 AT MACH NUMBER 0.28

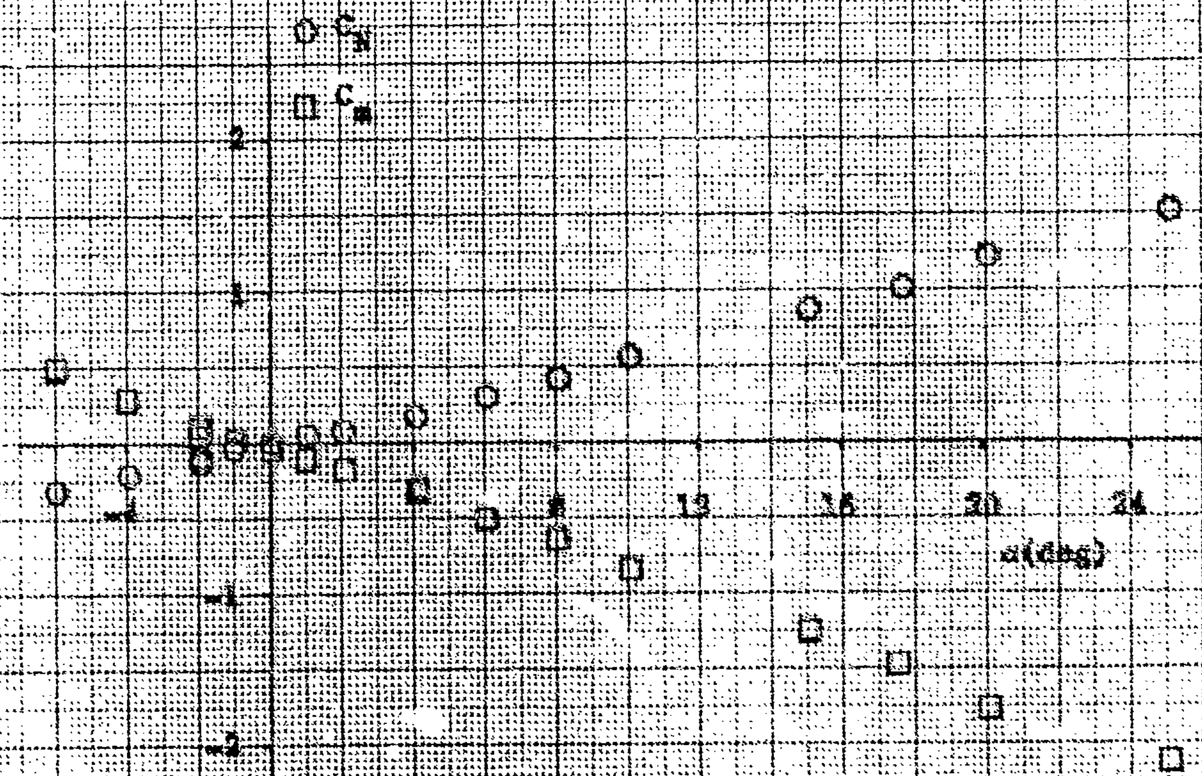

FIG. 13 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BF^{1}T^{+}$ AT MACH NUMBER 0.28

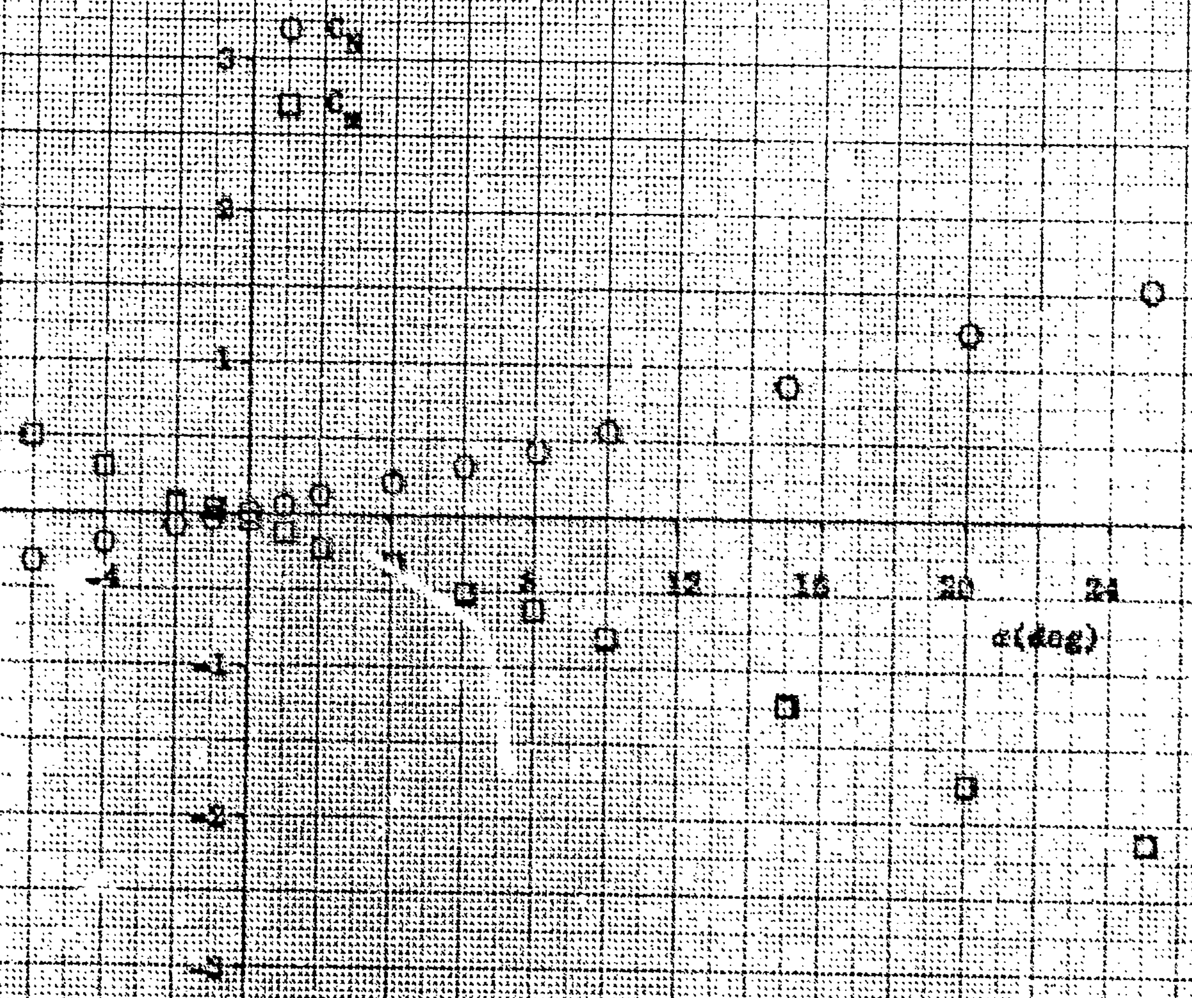

FIG. 1a NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $SLF^1T^1_1$ AT MACH NUMBER 0.22

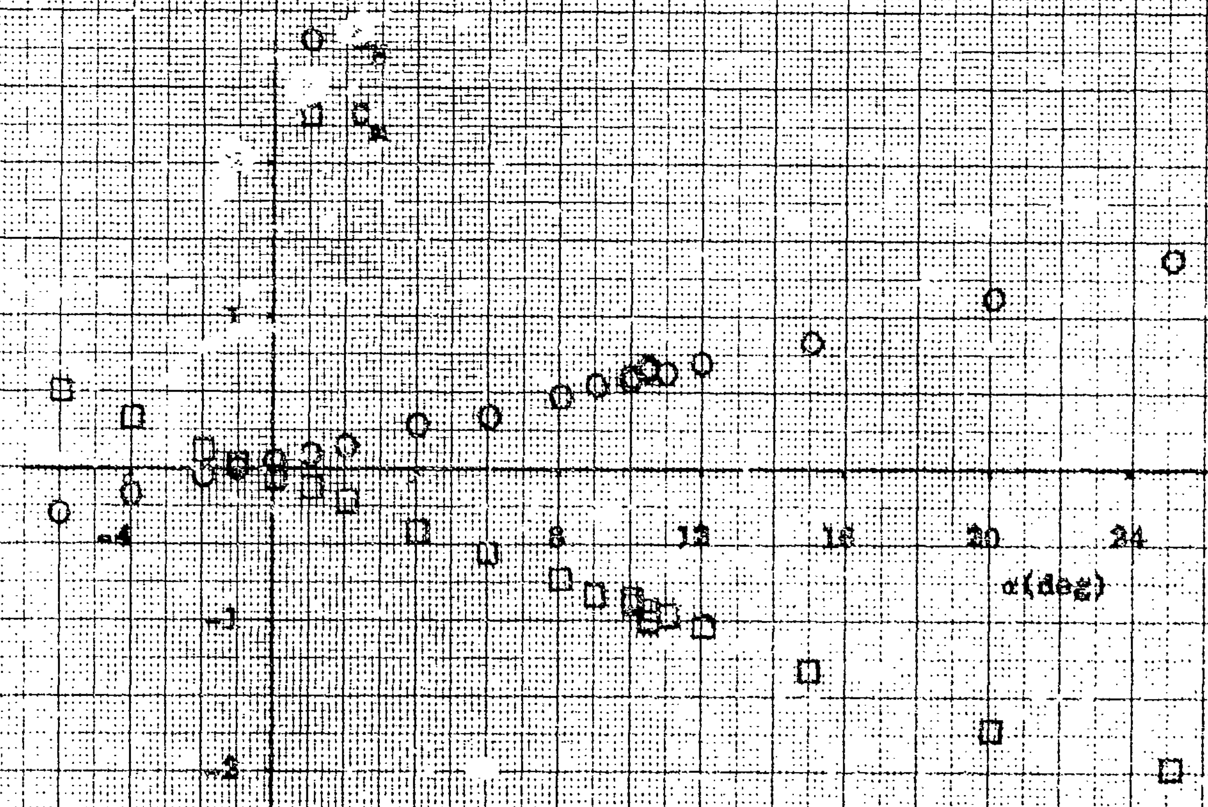

FIG. 15 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BT_1 AT MACH NUMBER 0.42

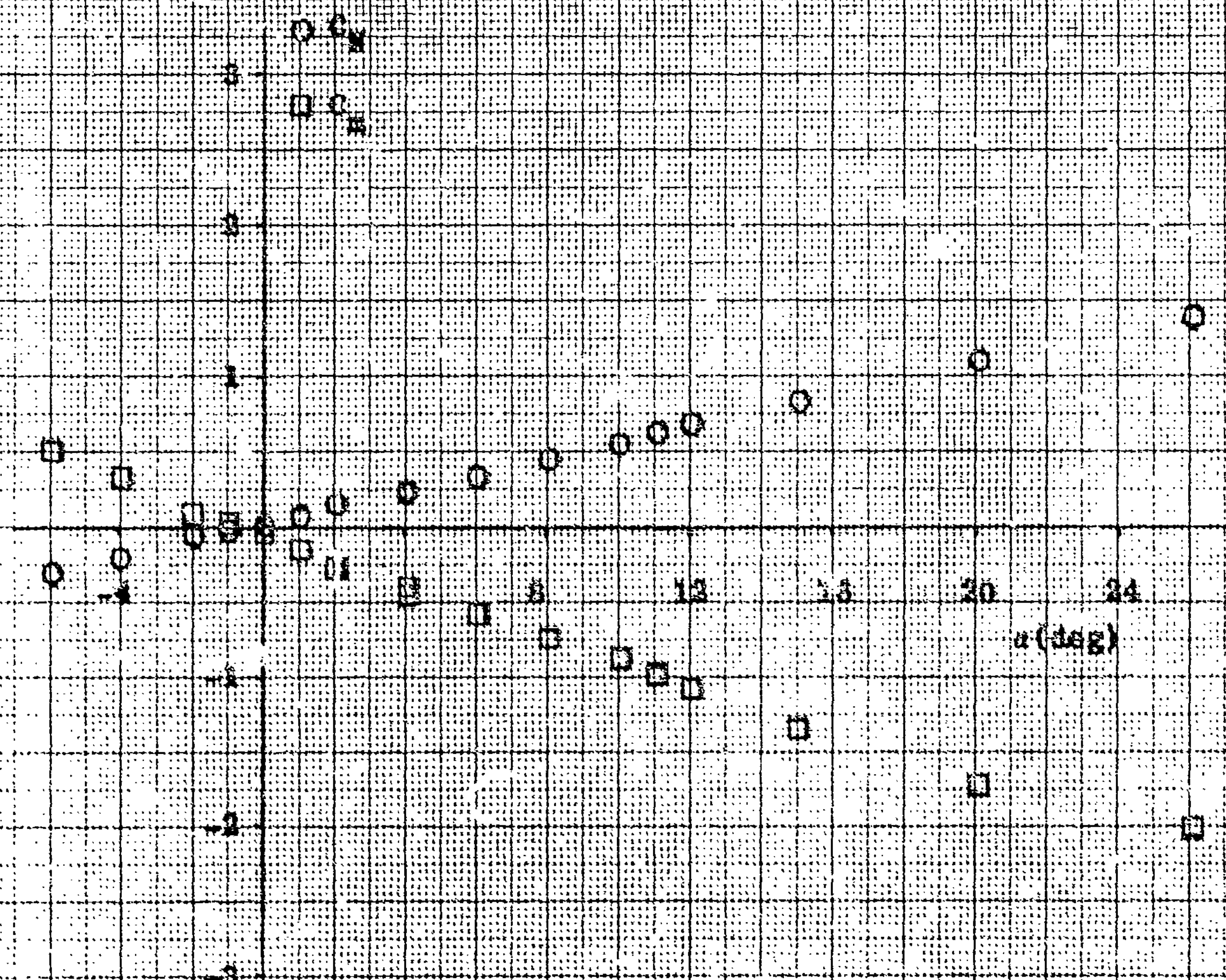

FIG. 13 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BWT$_1$ AT MACH NUMBER 0.40

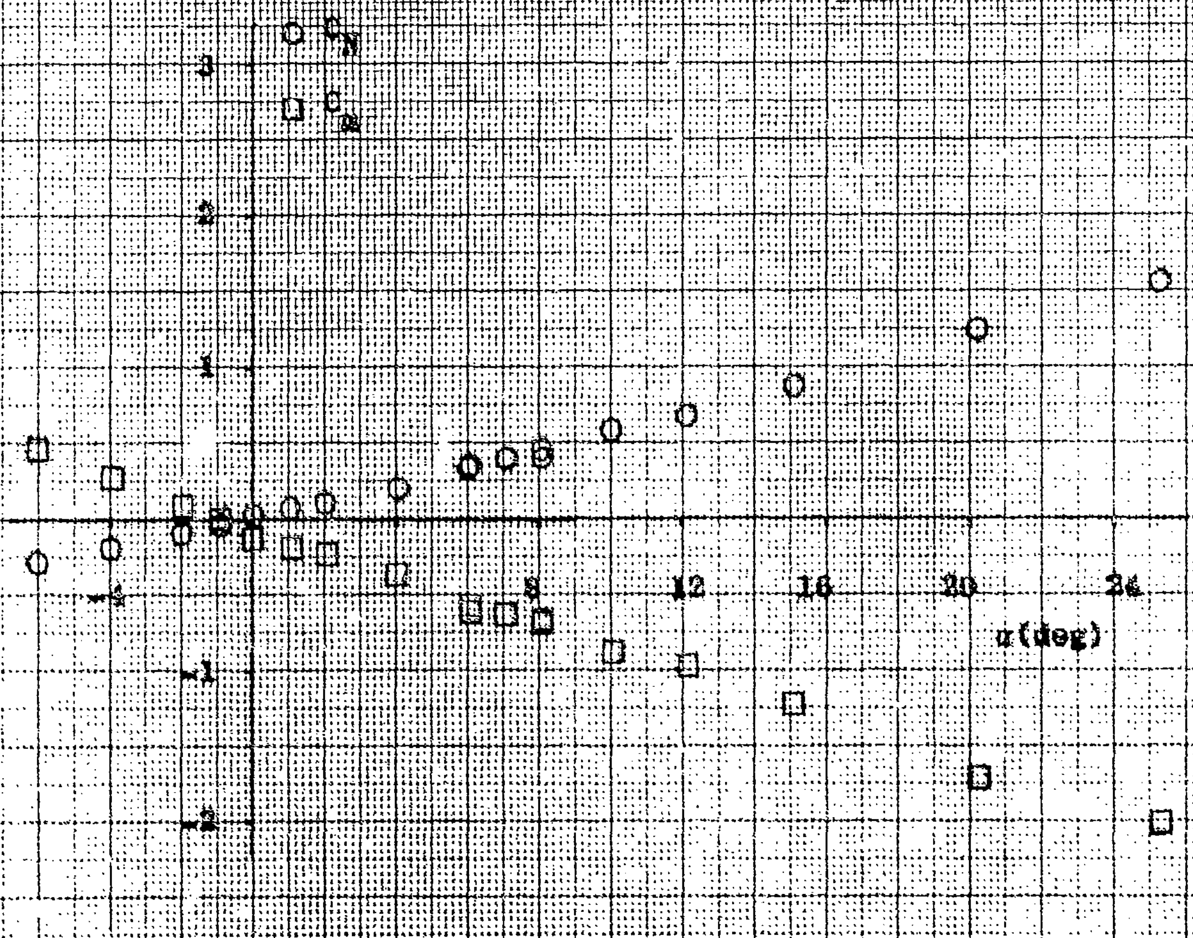

FIG. 17 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BF^1T_2^2$ AT MACH NUMBER 0.42

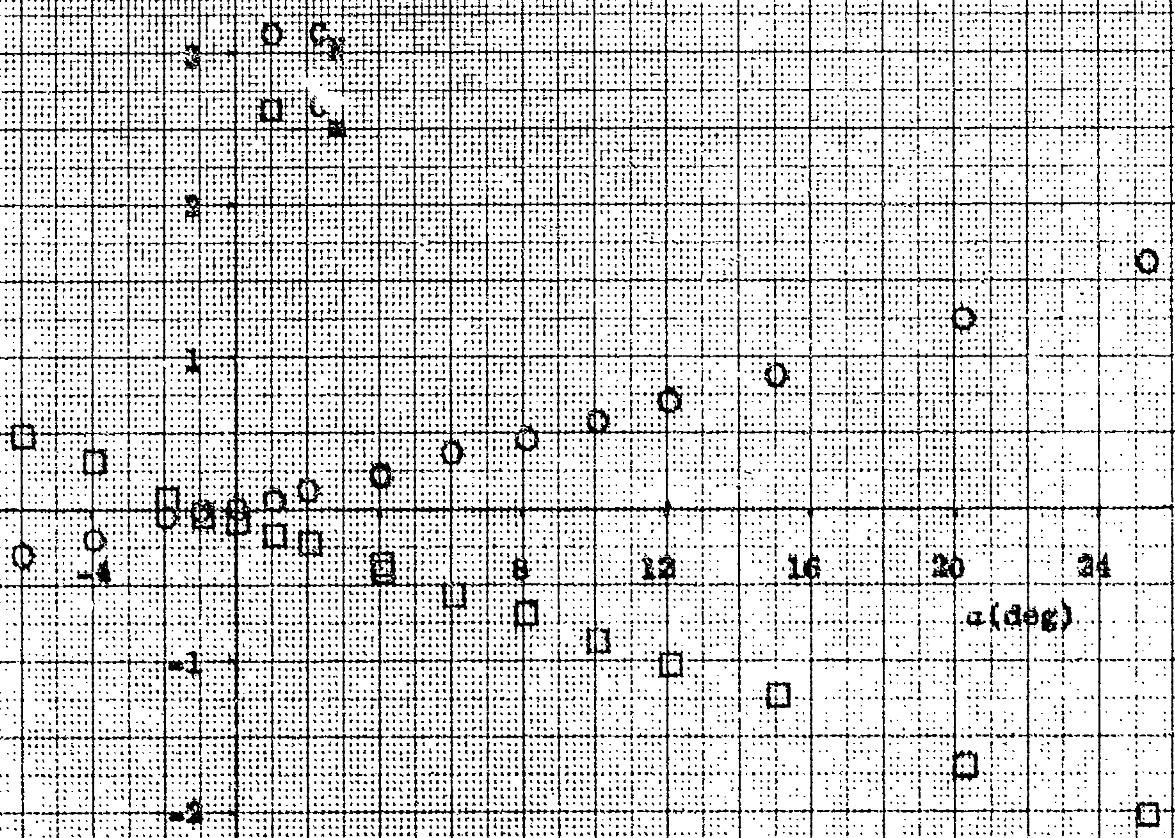

FIG. 18 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BLF^4T_1^1$ FOR MACH NUMBER 0.42

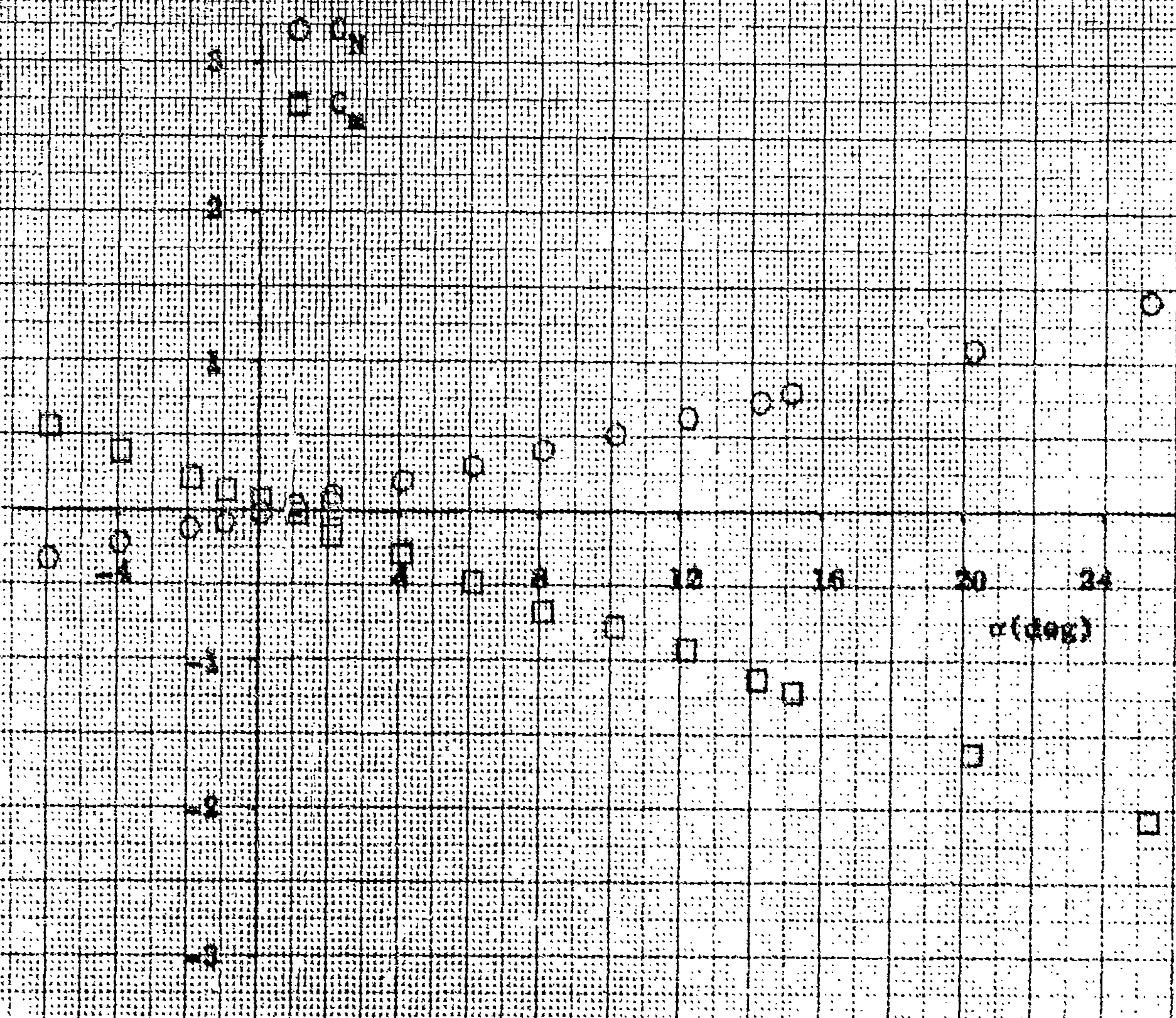

FIG. 19 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BC_1^N AT MACH NUMBER 0.50

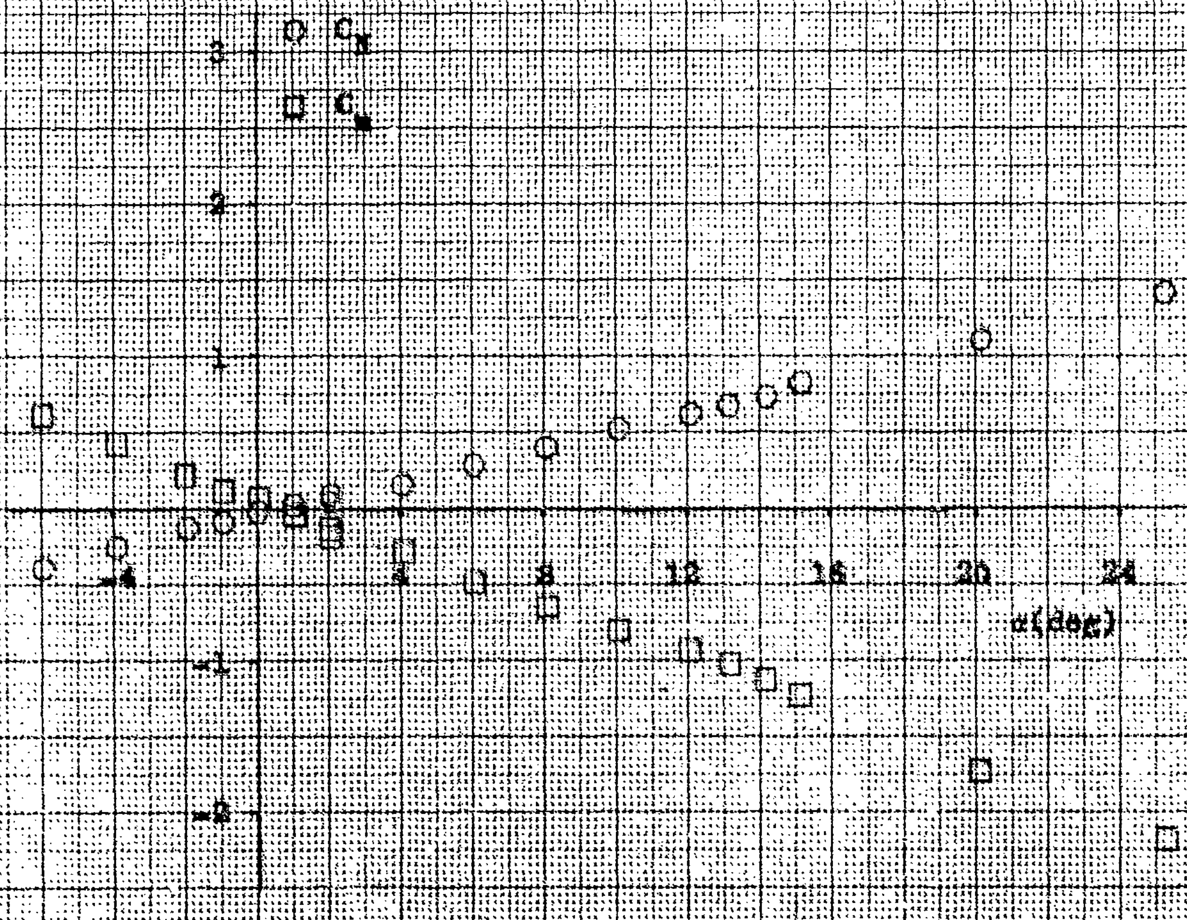

FIG. 20 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLT_1 AT MACH NUMBER 0.50

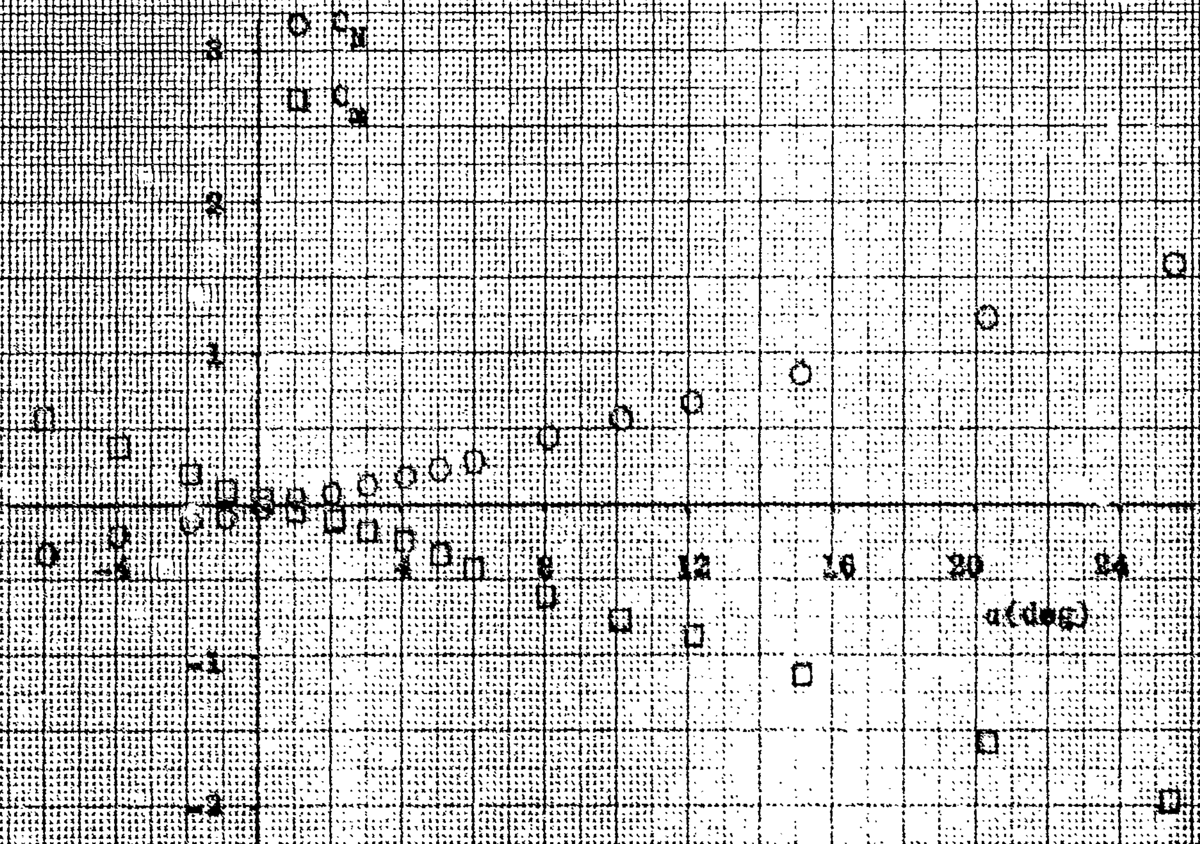

FIG. 21 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BF^1 T_1^1$ AT MACH NUMBER 0.50

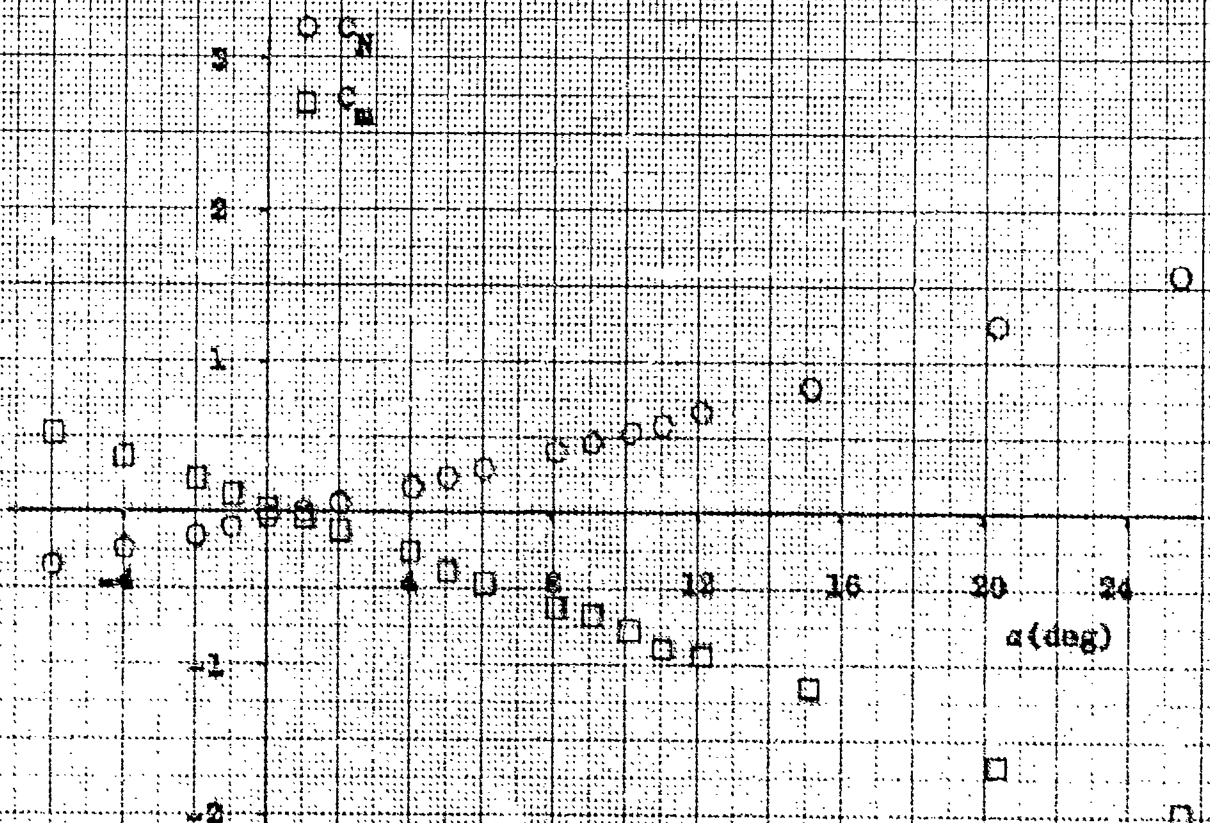

FIG. 22 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLF T_1 AT MACH NUMBER 0.50

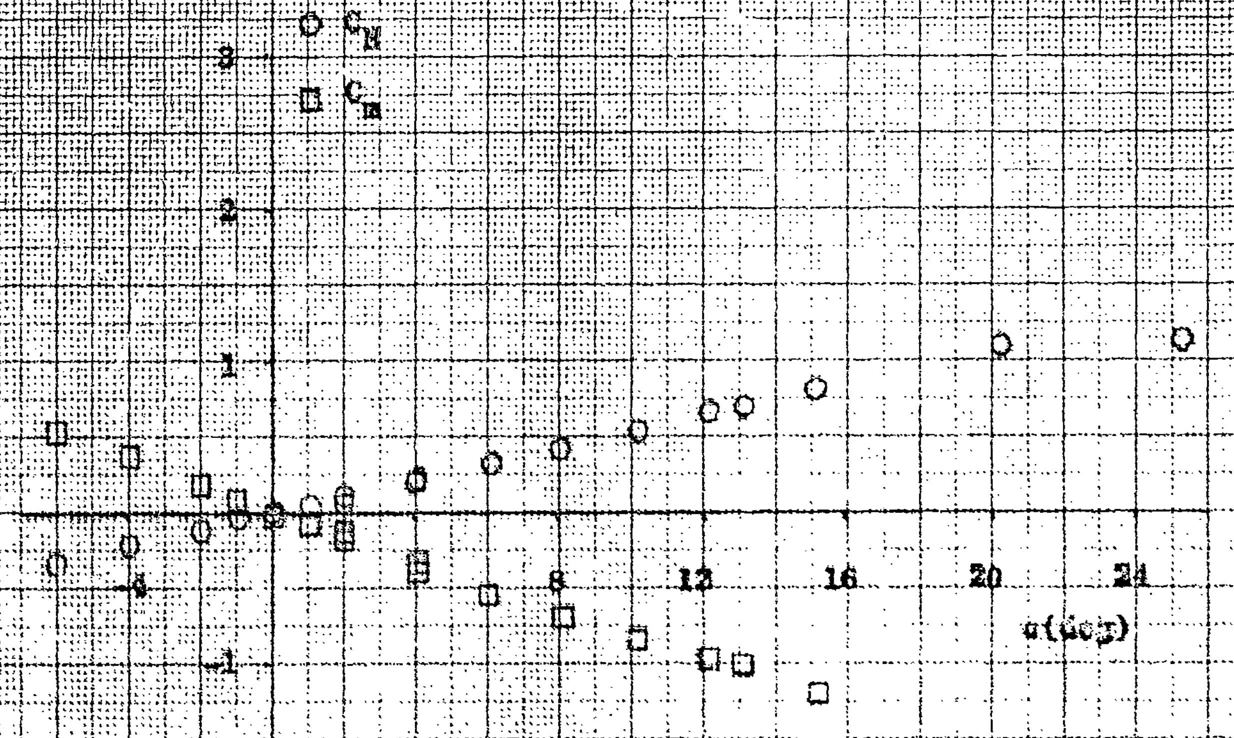

FIG. 23 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BT_1^3 AT MACH NUMBER 0.59

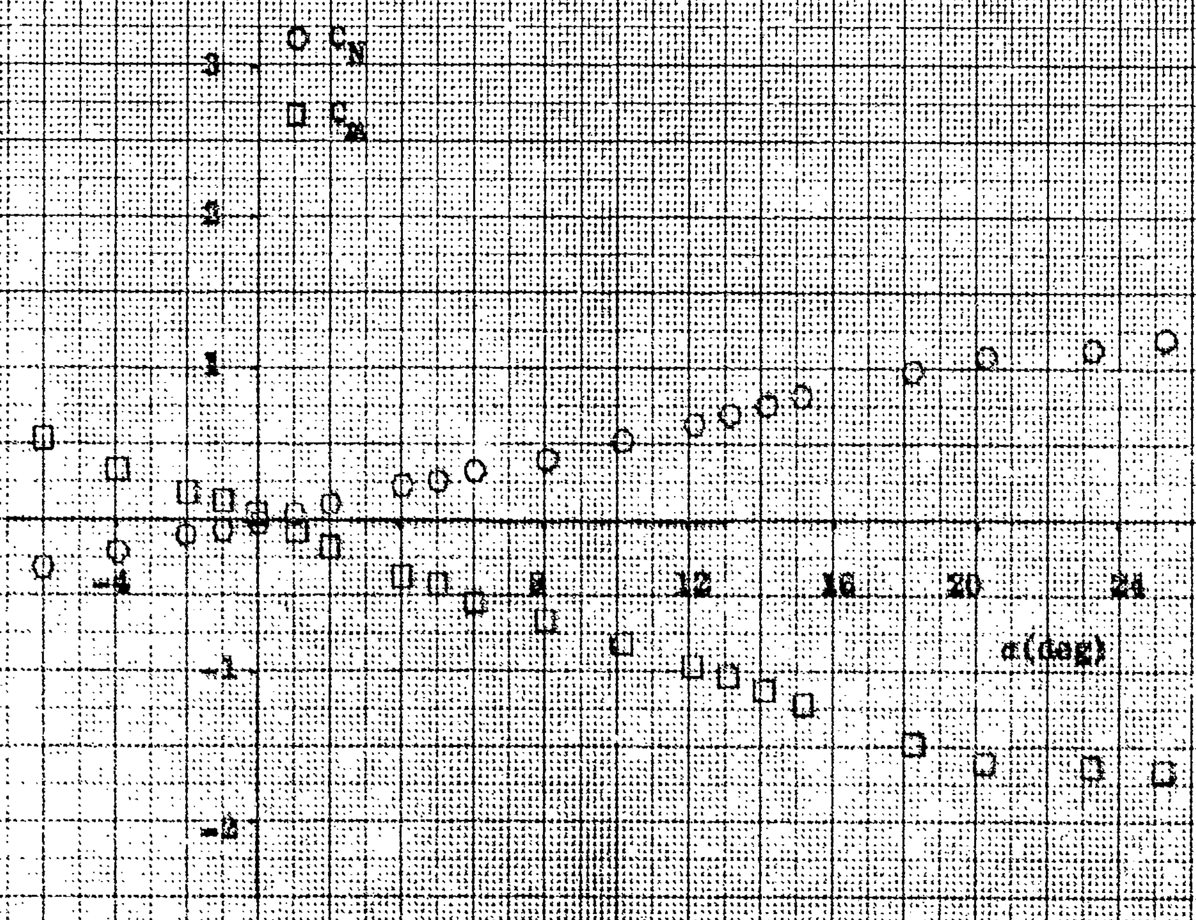

FIG. 24 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION ELT_1 AT MACH NUMBER 0.39

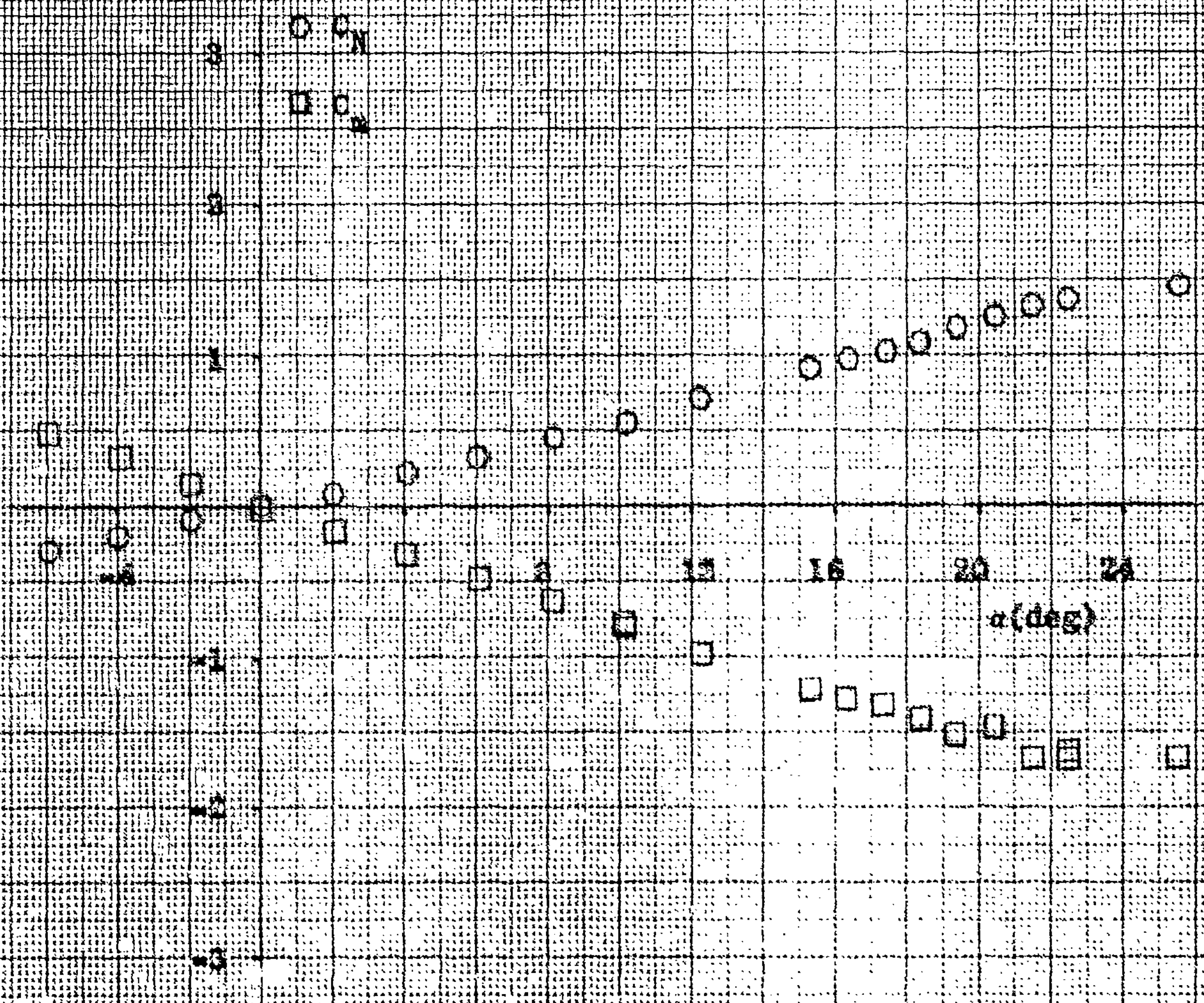

FIG. 23 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BF^{*}T_{1}^{*}$ AT MACH NUMBER 0.59

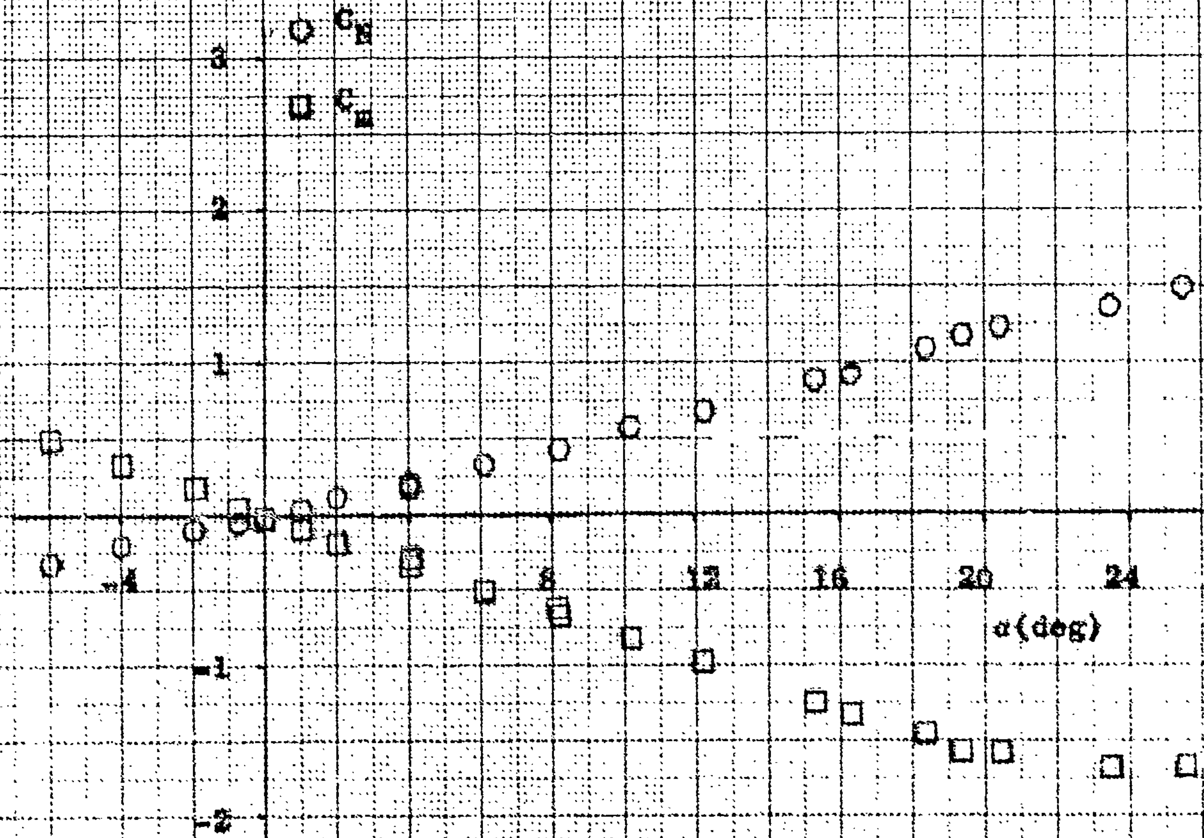

FIG. 26 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BLF^1T^1_1$ AT MACH NUMBER 0.59

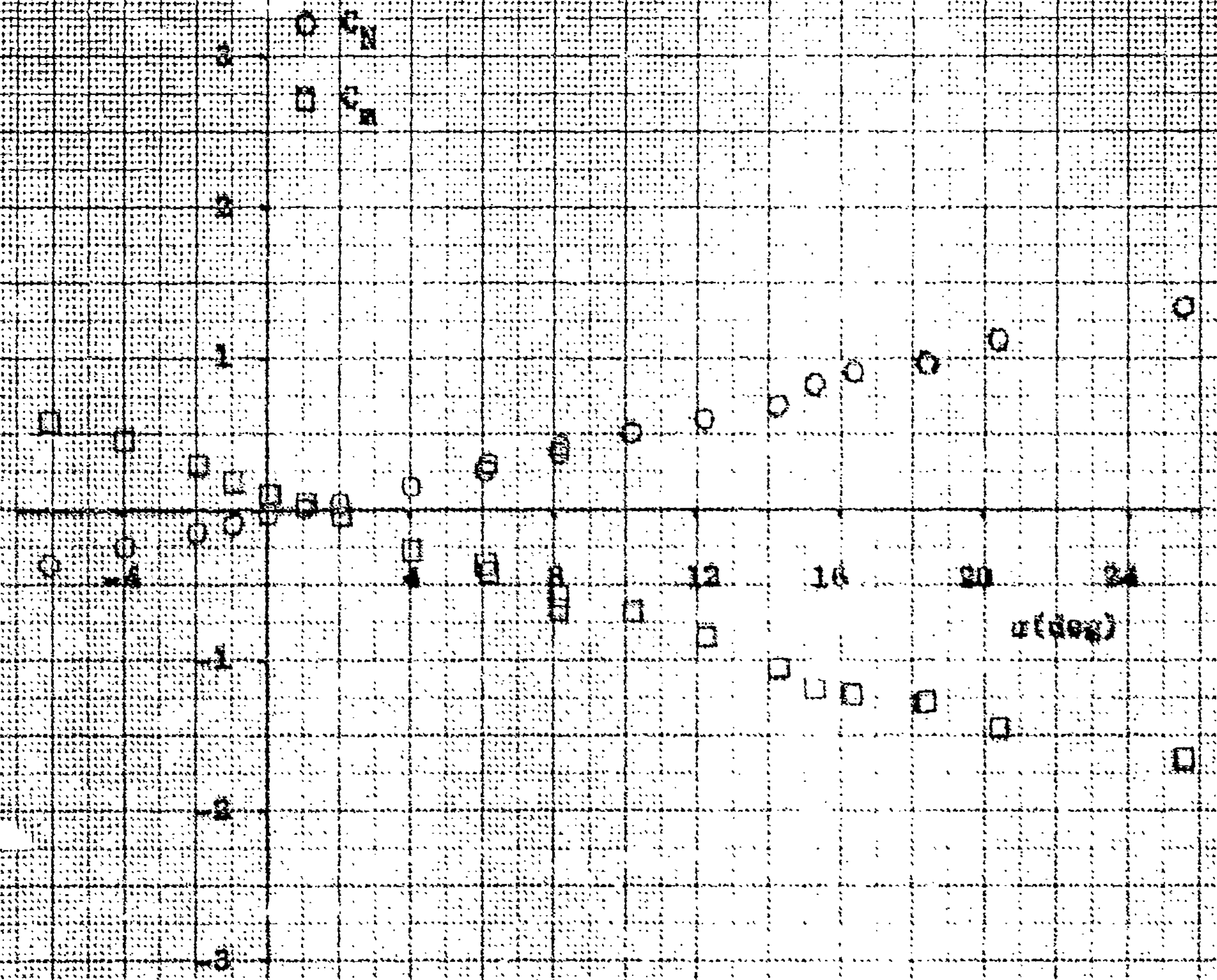

FIG. 27 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BDY_1^5 AT MACH NUMBER 0.72

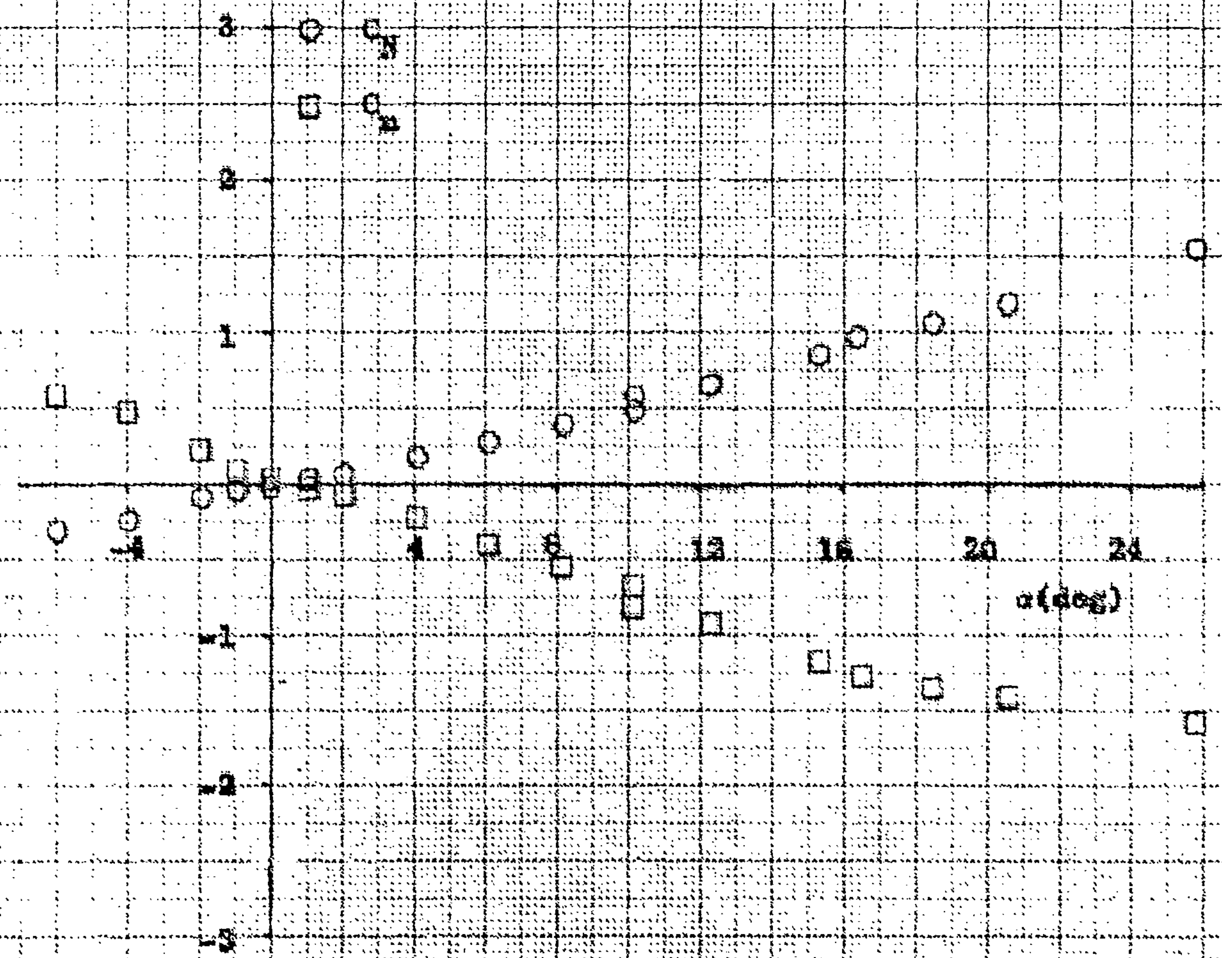

FIG. 38 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BLF^2T_1^0$ AT MACH NUMBER 0.72

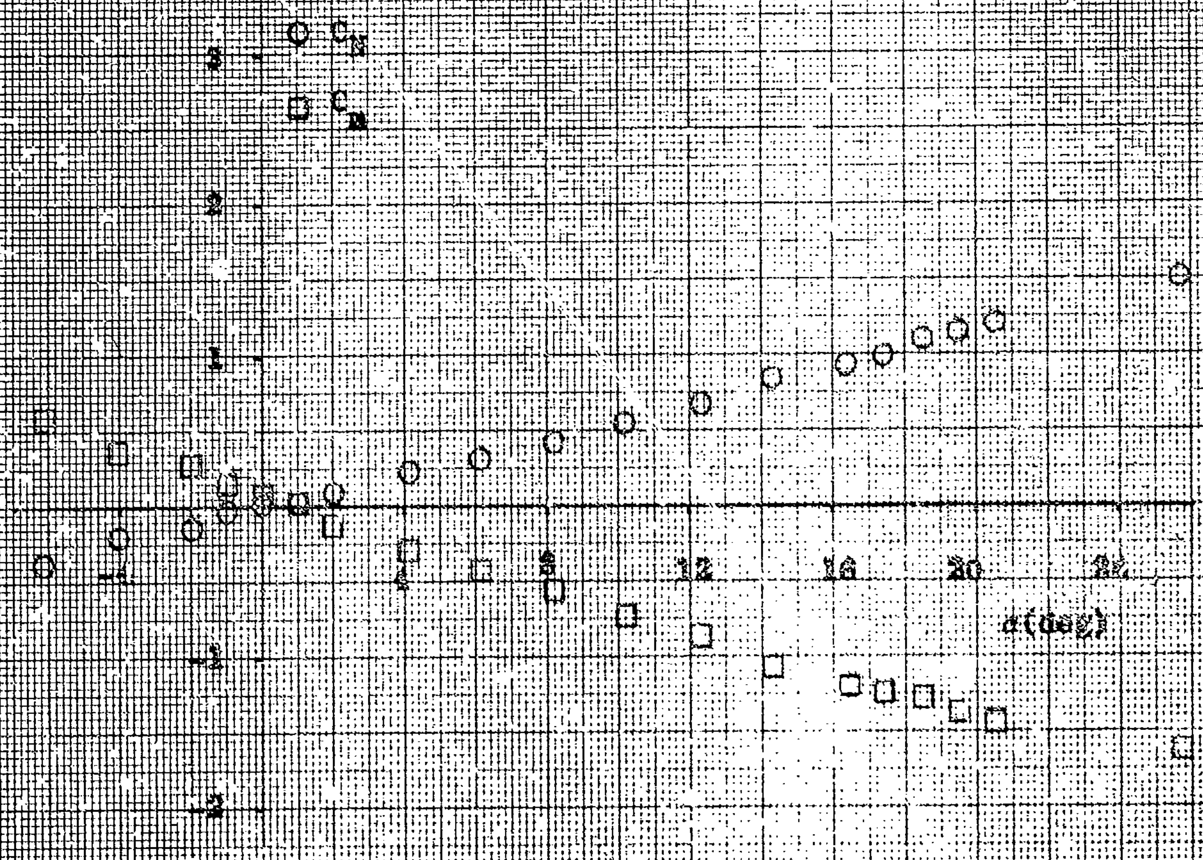

FIG. 29 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLT_1 AT MACH NUMBER 0.85

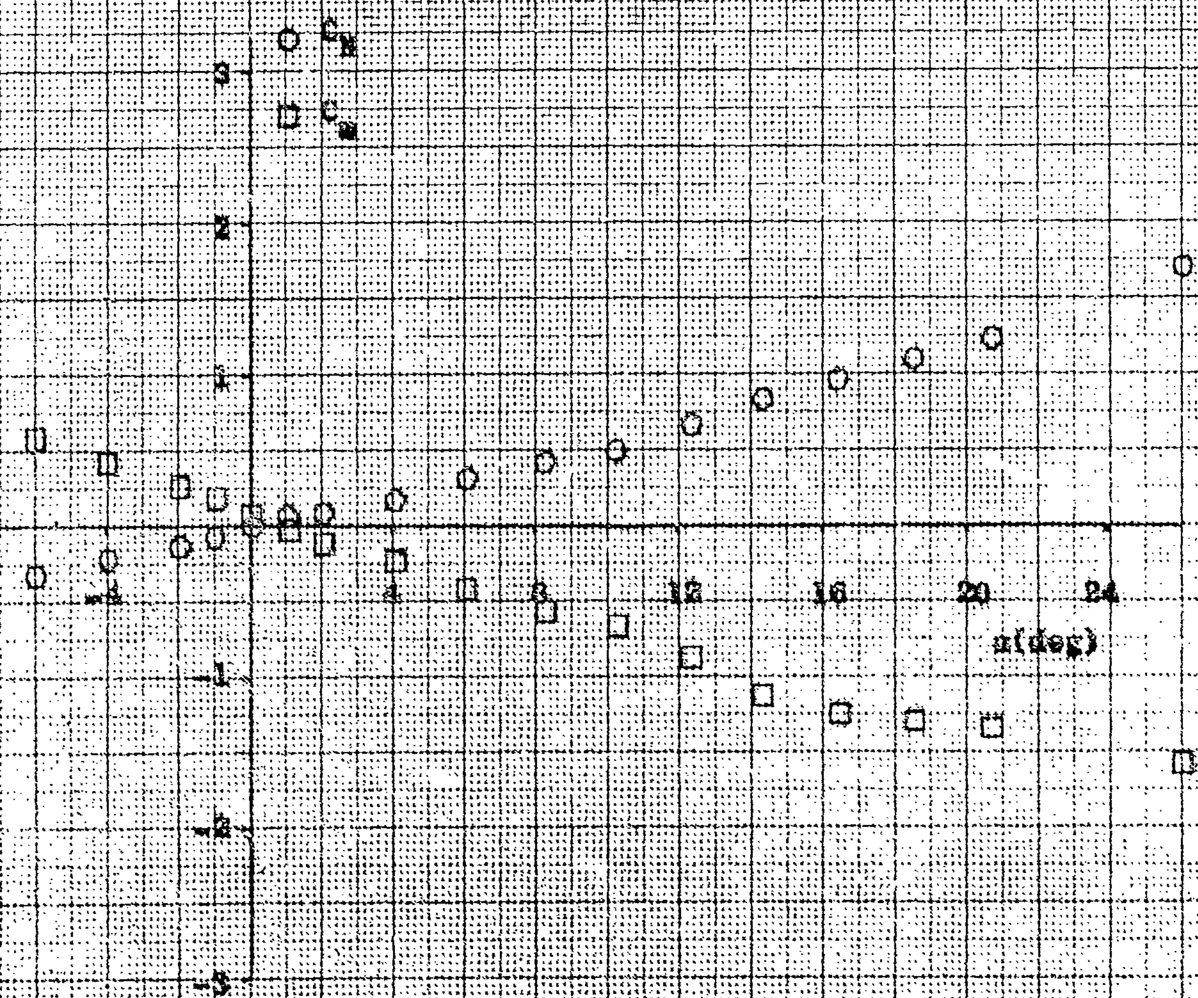

FIG. 30 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BL^1T_1^2$ AT MACH NUMBER 0.85

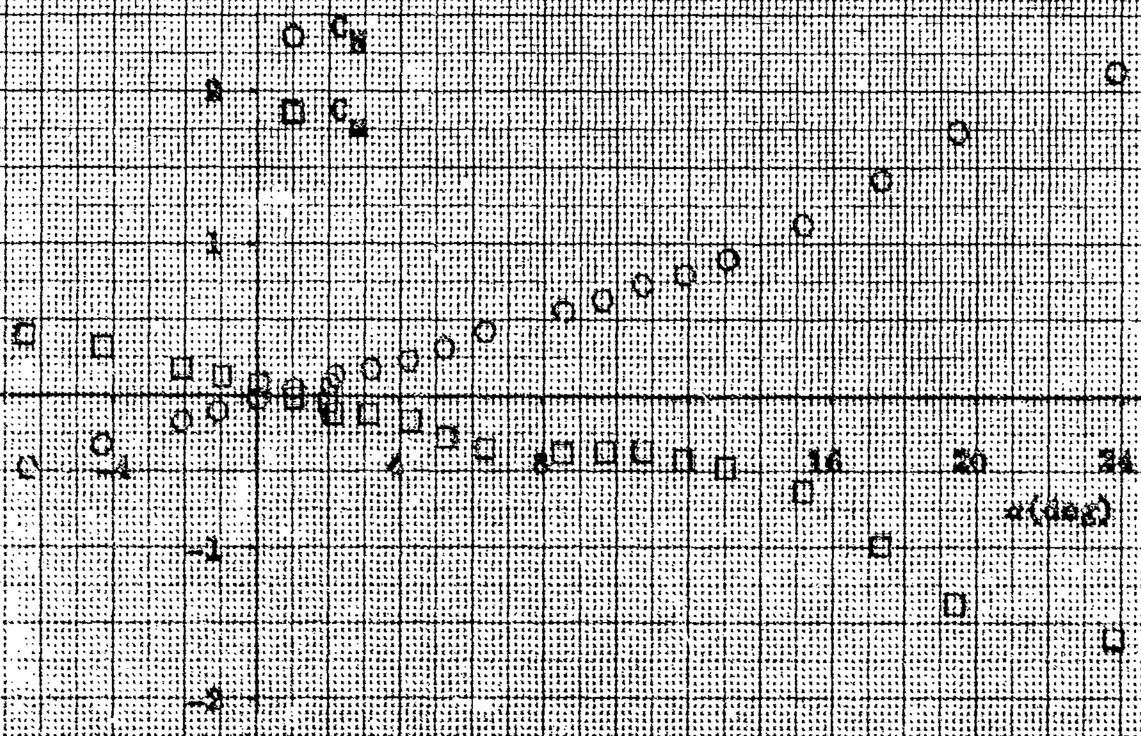

FIG. 31 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLT$_1$ AT MACH NUMBER 1.75

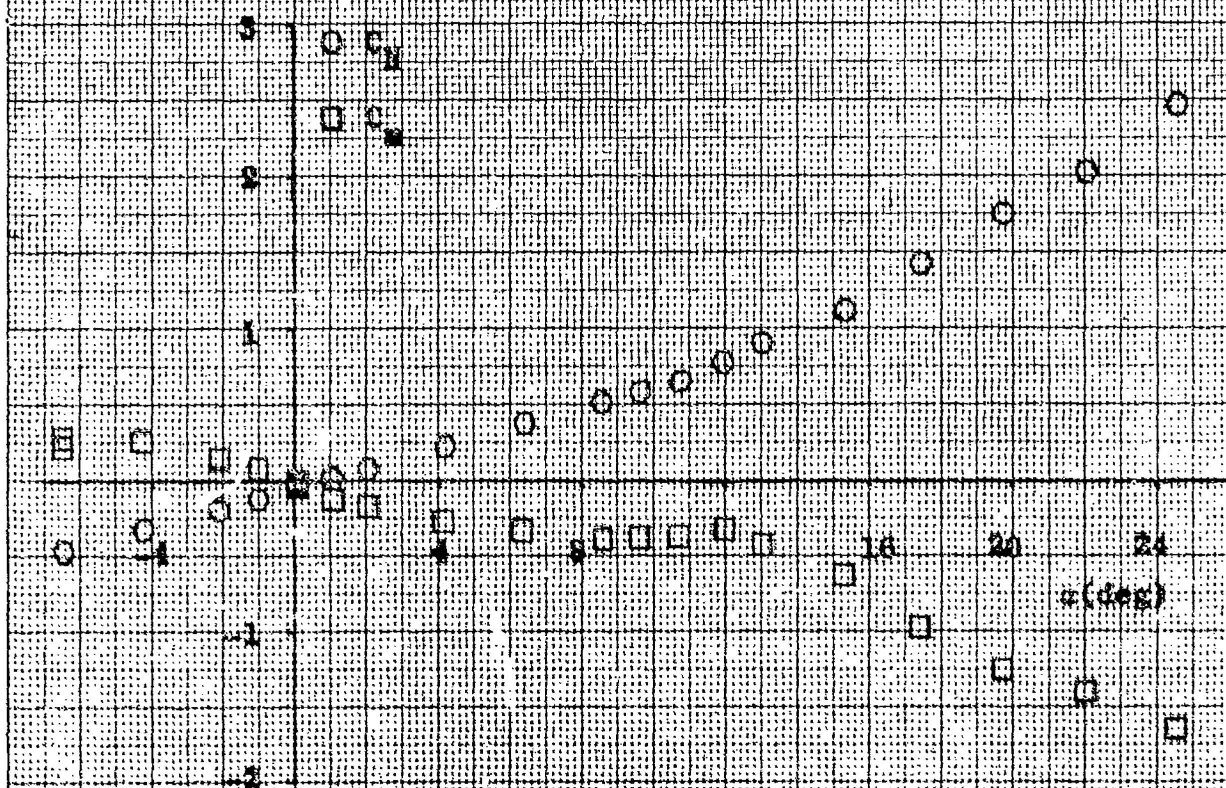

FIG. 32 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLF^2 T$_1^2$ AT MACH NUMBER 1.75

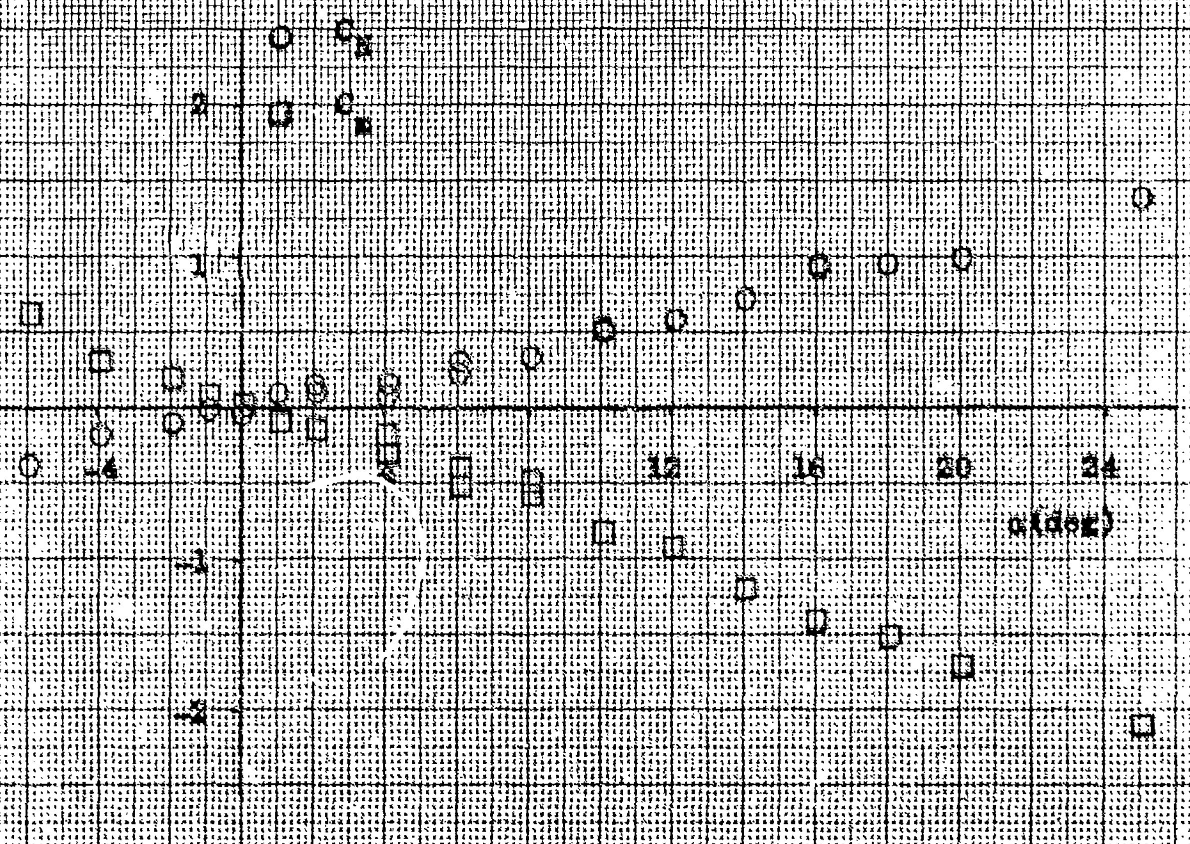

FIG. 23 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLT_s AT MACH NUMBER 0.23

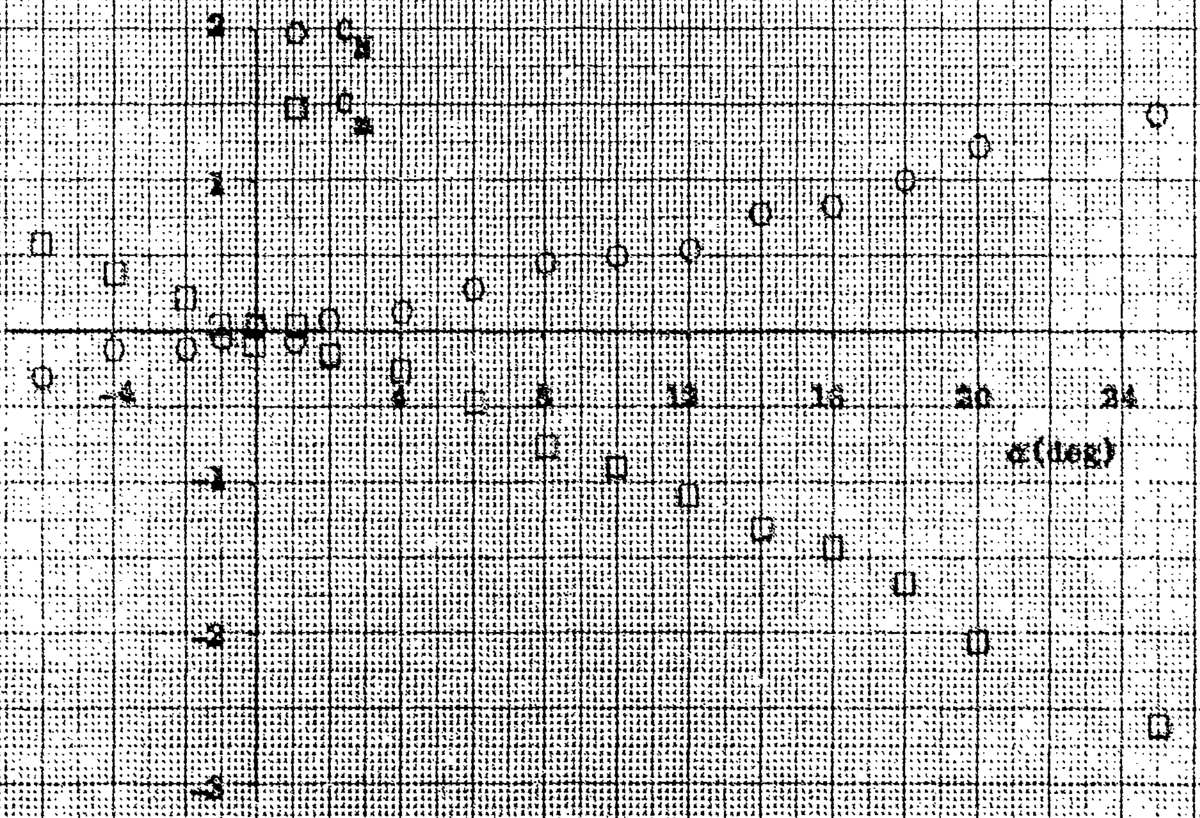

FIG. 34 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BL^*T_3' AT MACH NUMBER 0.23

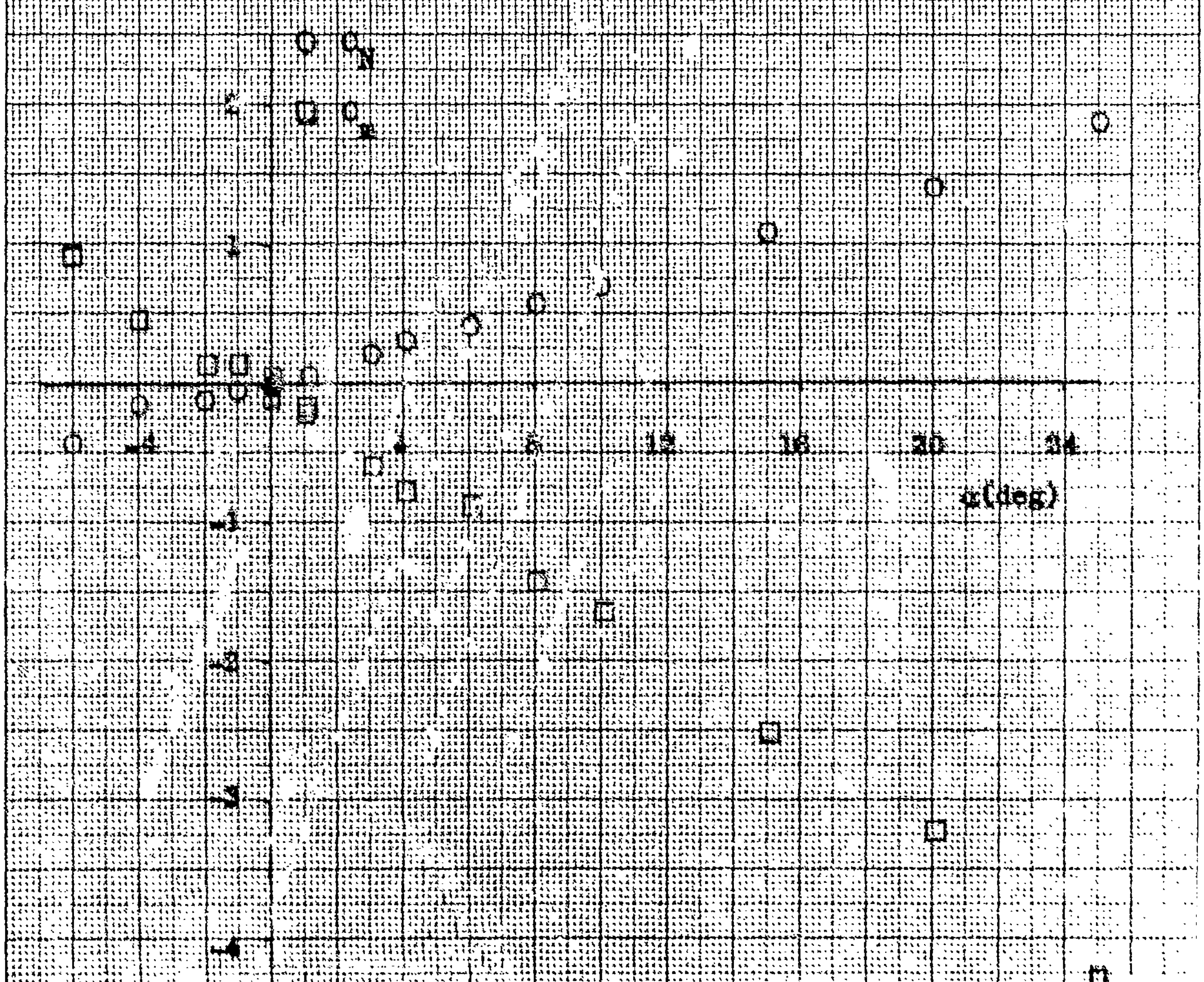

FIG. 35 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLT_1^2 AT MACH NUMBER 0.23

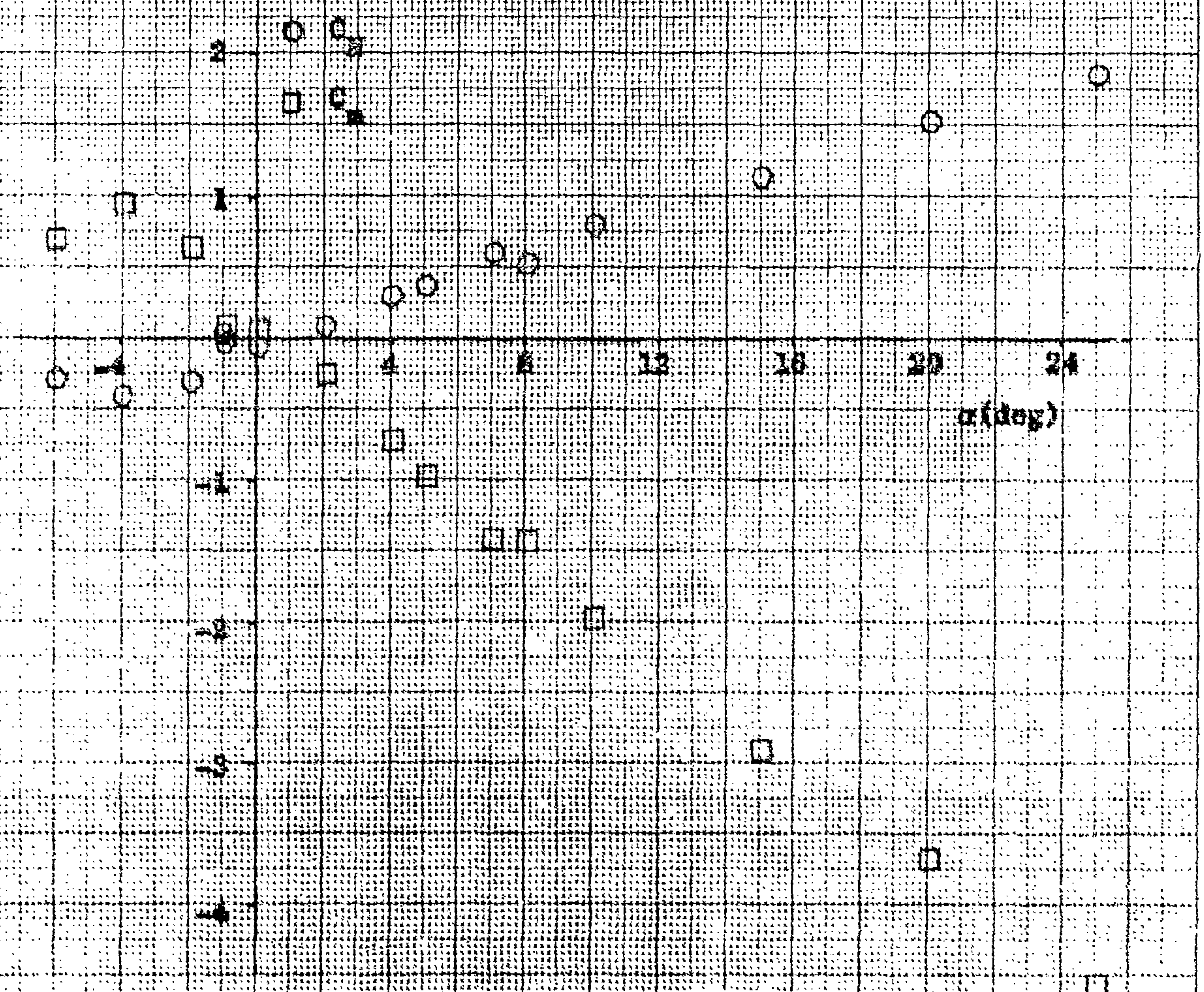

FIG. 35 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLT^2 AT MACH NUMBER 0.23

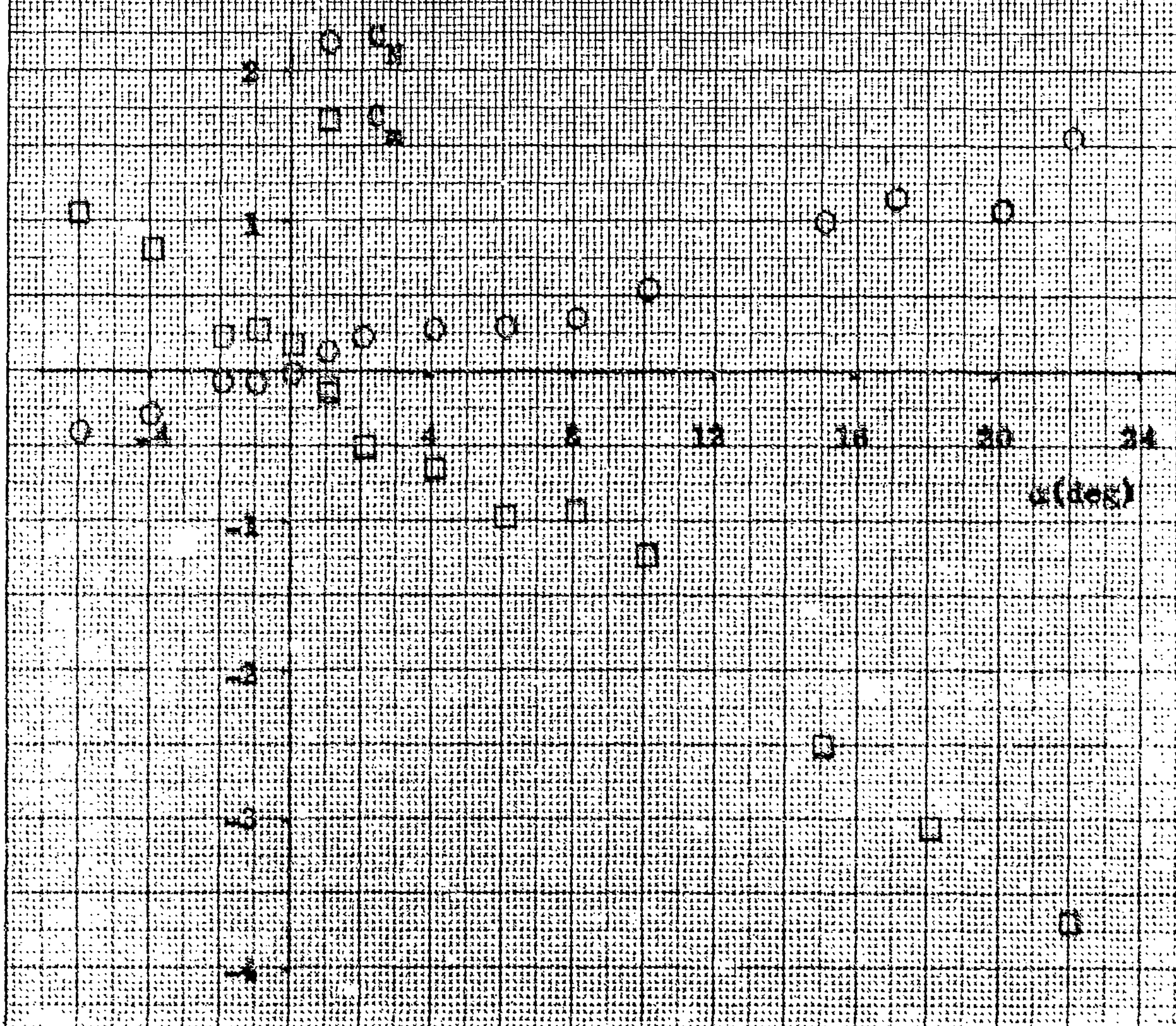

FIG. 37 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLF^{A}T$^{M}_{S}$ AT MACH NUMBER 0.23

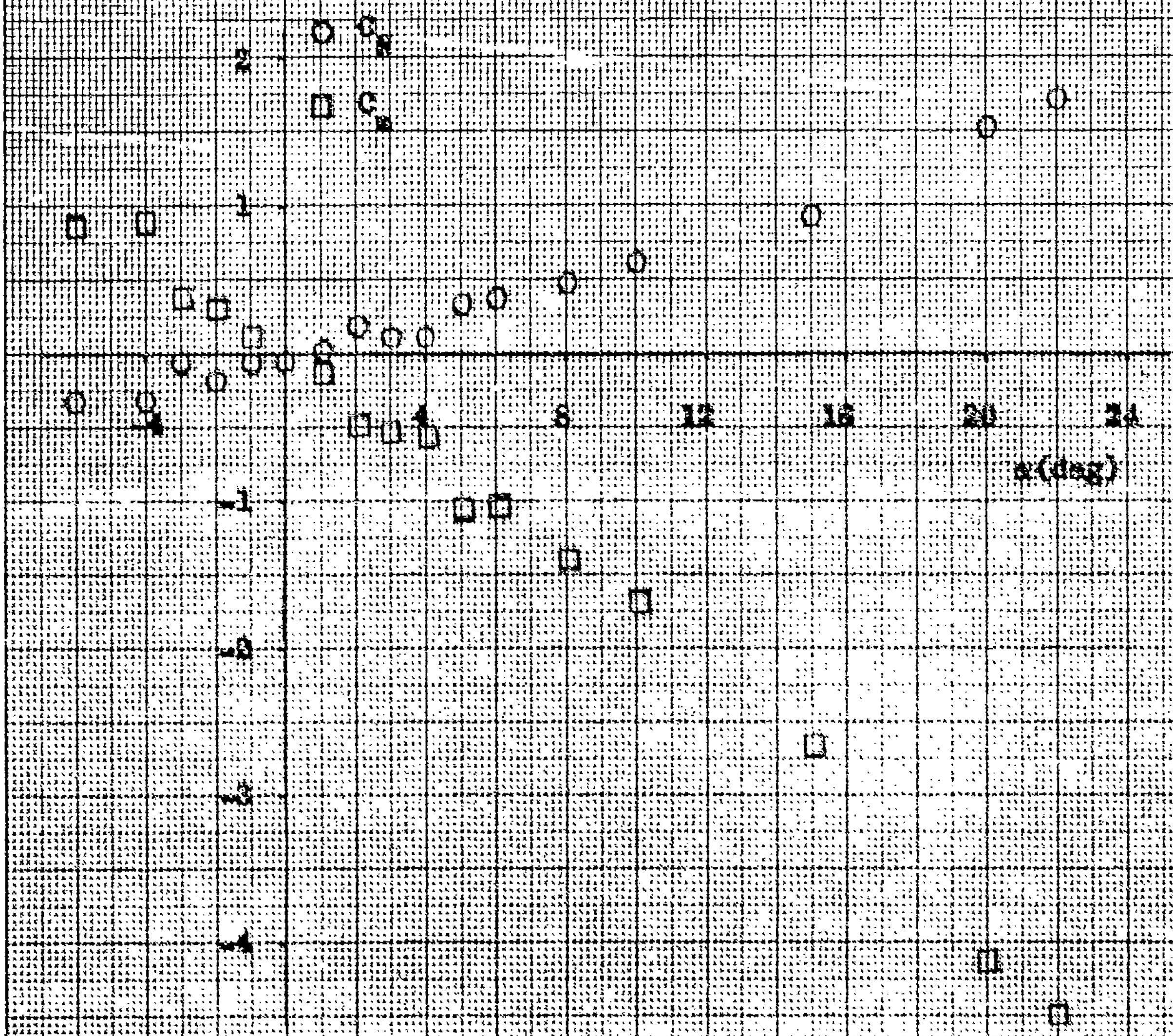

FIG. 38 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BLF^{0}T^{4}_{s}$ AT MACH NUMBER 0.23

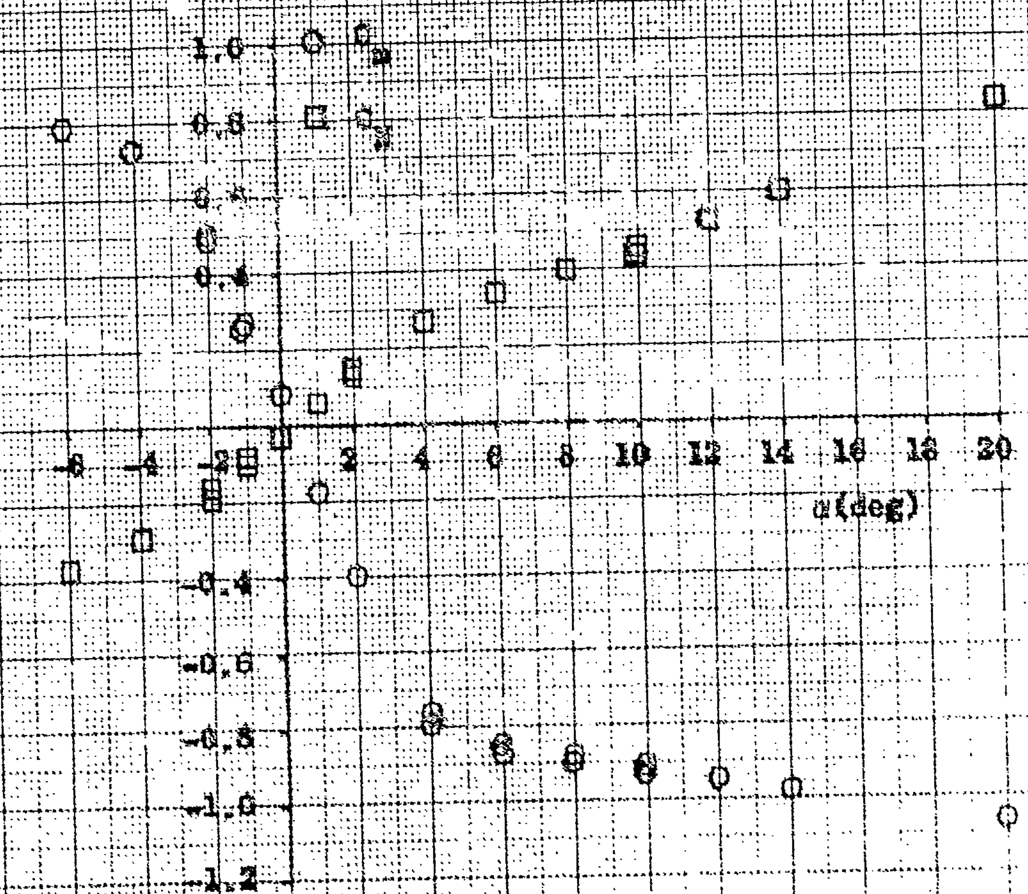

FIG. 39 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLT9 AT MACH NUMBER 0.79

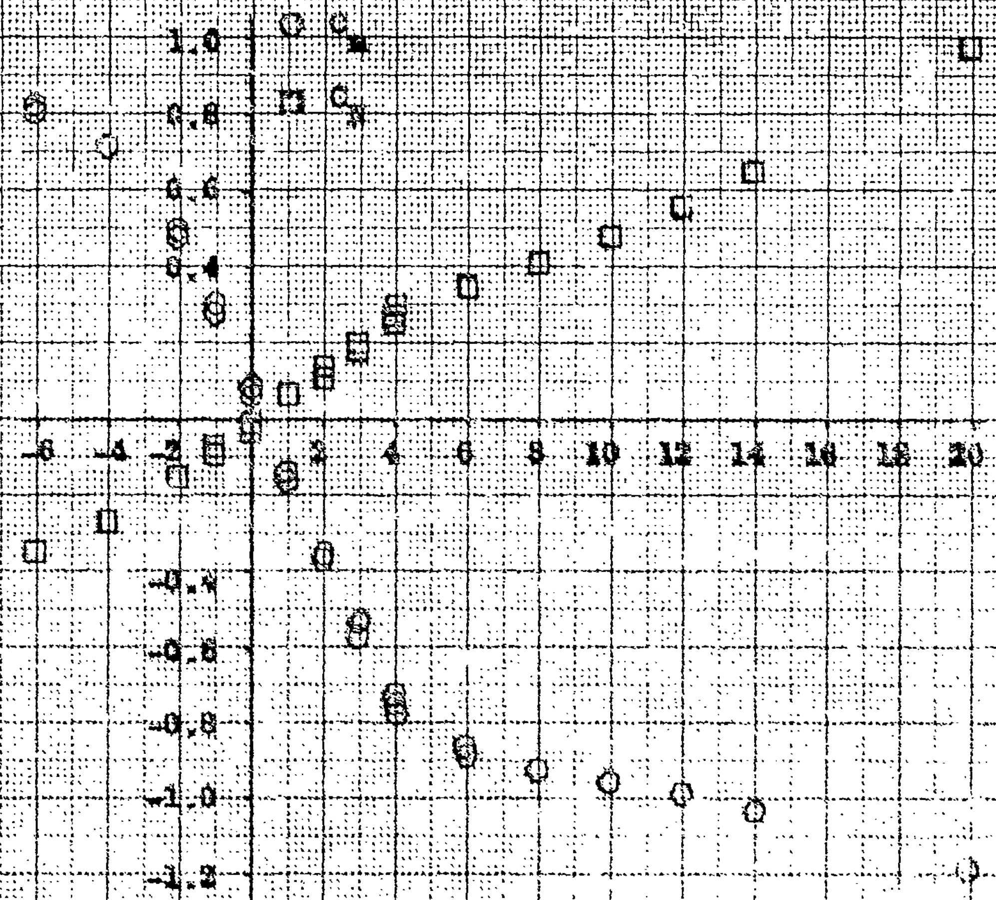

FIG. 40 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION $BL^{2}T^{3}$ AT MACH NUMBER 0.79

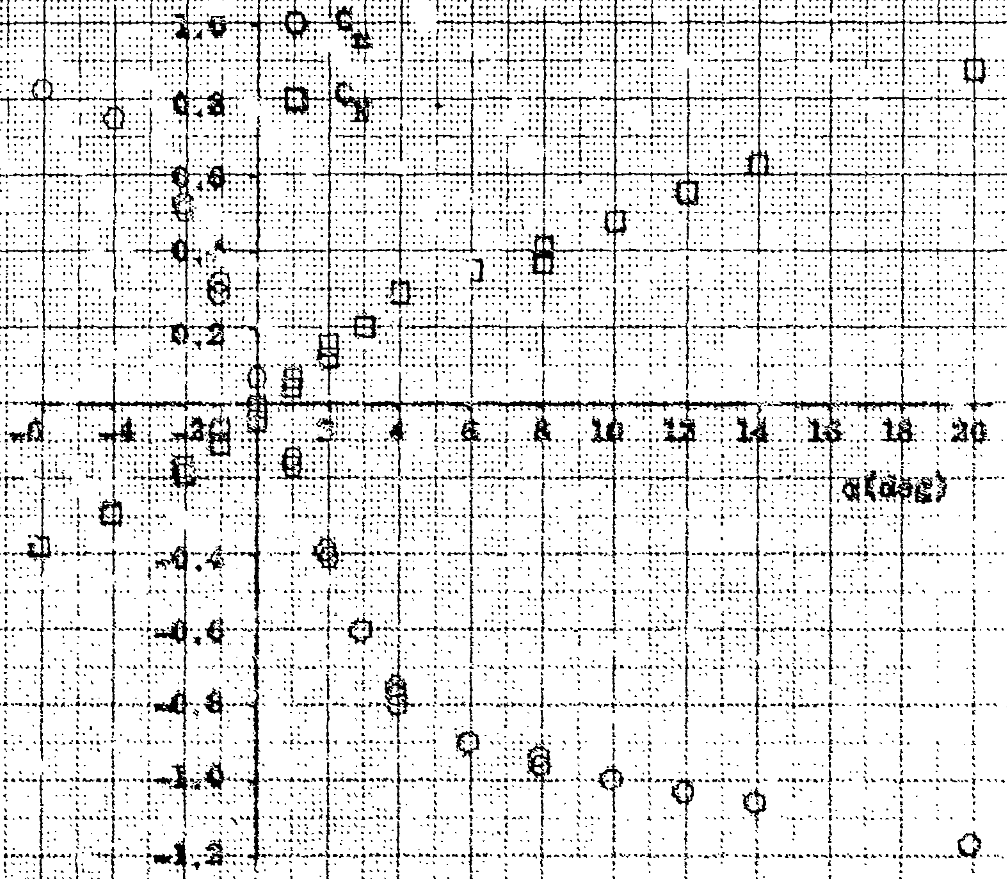

FIG. 41 NORMAL FORCE COEFFICIENT AND PITCHING MOMENT COEFFICIENT VERSUS ANGLE OF ATTACK FOR CONFIGURATION BLF^4T^4 AT MACH NUMBER 0.79

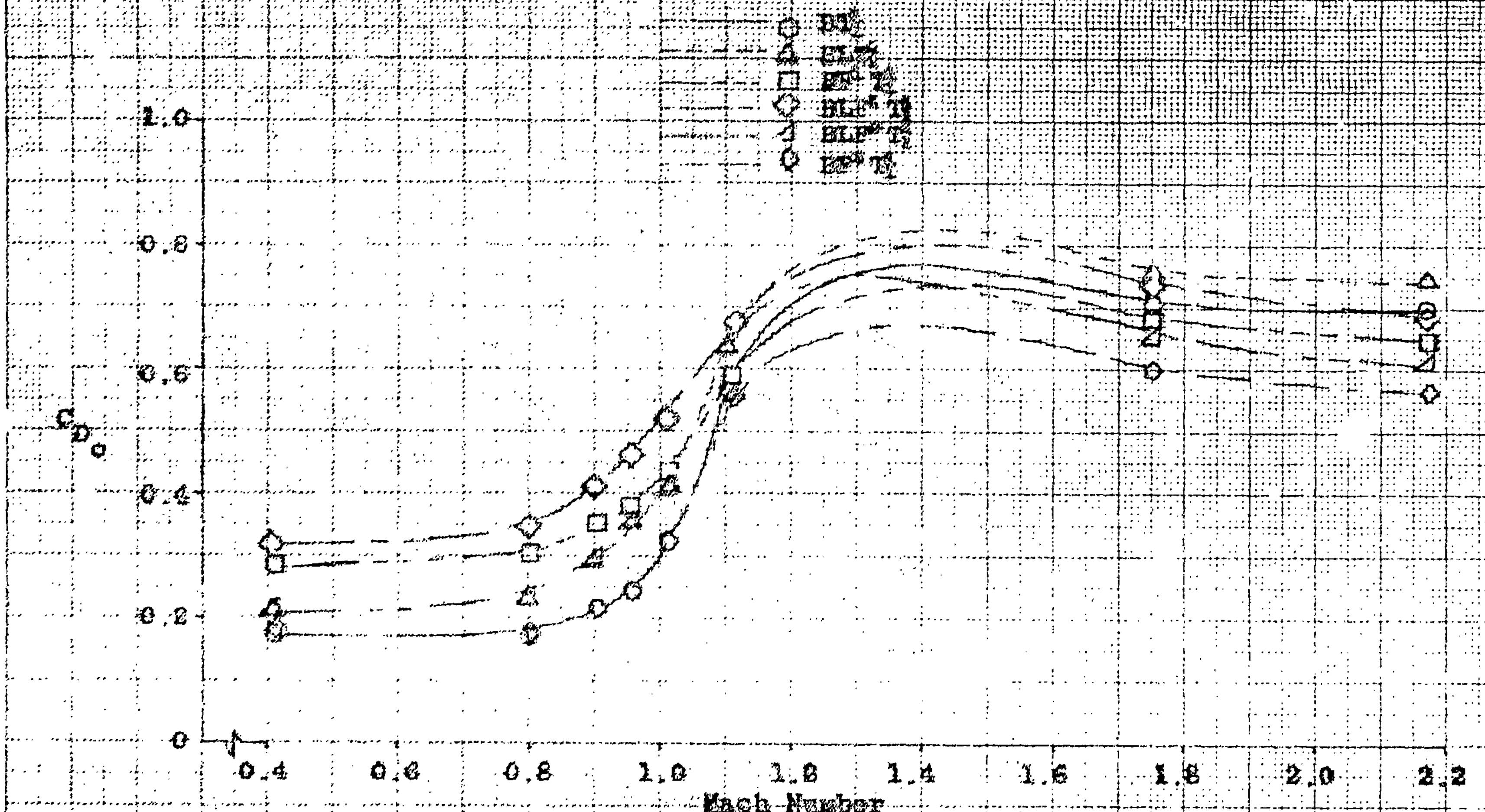

FIG. 42 DRAG COEFFICIENT VERSUS MACH NUMBER FOR CONFIGURATIONS USING THE T_1^c TAIL

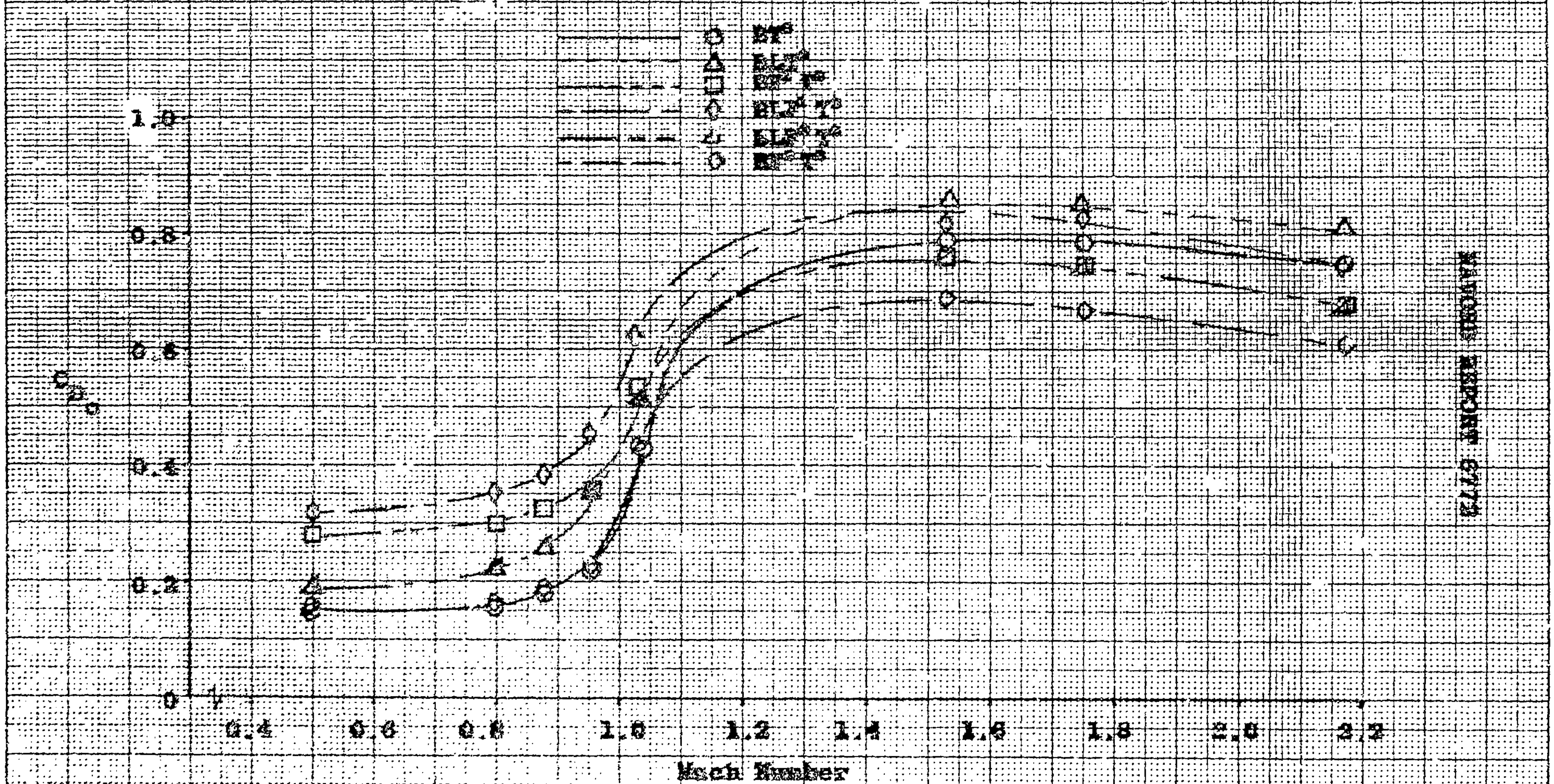

FIG. 43 DRAG COEFFICIENT VERSUS MACH NUMBER FOR CONFIGURATIONS USING THE T^c TAIL

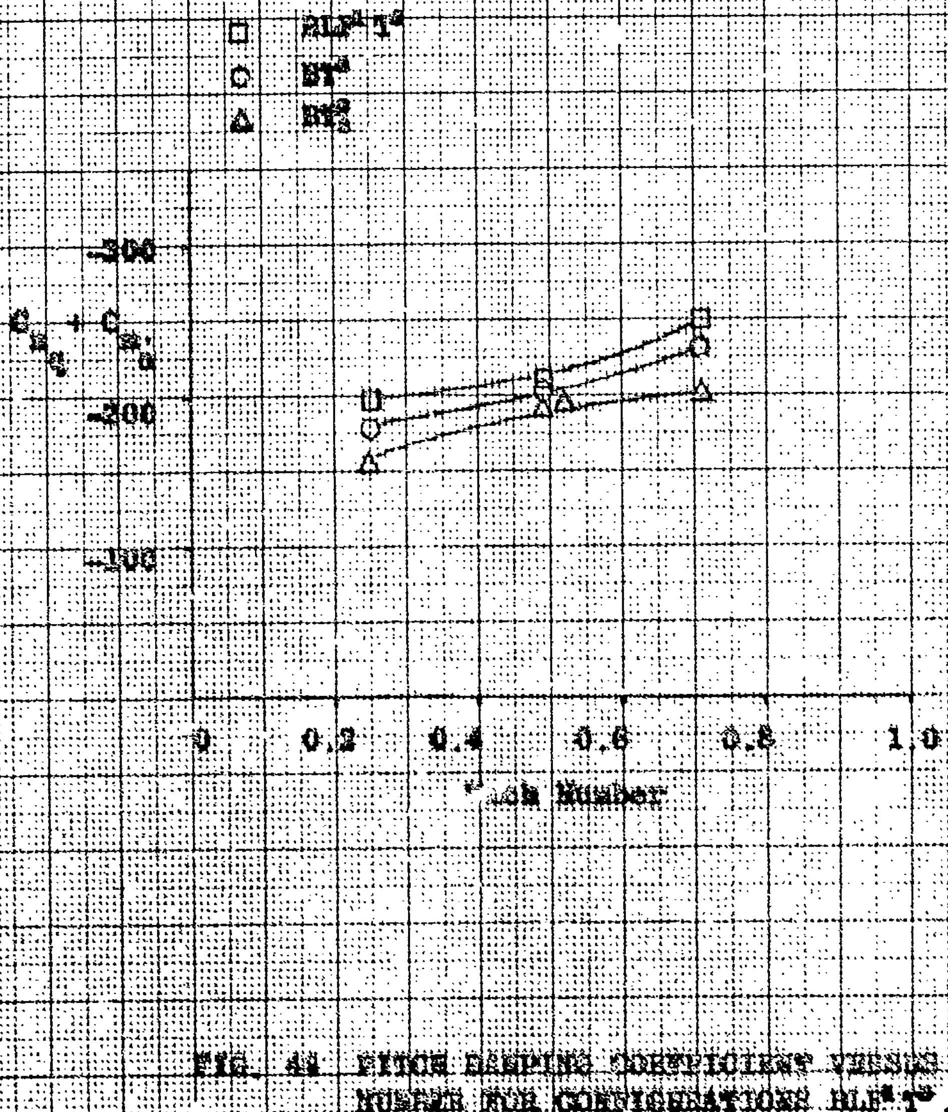

FIG. 44 PITCH DAMPING COEFFICIENT VERSUS MACH NUMBER FOR CONFIGURATIONS $BLF^{a}T^{c}$, BT^{c} AND BT^{c}_{3}

TABLE 1

INDEX OF STATIC STABILITY, DRAG AND PITCH DAMPING MEASUREMENTS

Figure	Configuration	Mach No.
	Index of Static Stability Measurements	
11	BT_1^1	0.29
12	BLT_1^1	0.29
13	$BF^1 T_1^1$	0.29
14	$BLF^1 T_1^1$	0.29
15	BT_1^1	0.42
16	BLT_1^1	0.42
17	$BF^1 T_1^1$	0.42
18	$BLF^1 T_1^1$	0.42
19	BT_1^1	0.50
20	BLT_1^1	0.50
21	$BF^1 T_1^1$	0.50
22	$BLF^1 T_1^1$	0.50
23	BT_1^1	0.59
24	BLT_1^1	0.59
25	$BF^1 T_1^1$	0.59
26	$BLF^1 T_1^1$	0.59
27	BLT_1^1	0.72
28	$BLF^1 T_1^1$	0.72
29	BLT_1^1	0.85

TABLE 1 (Cont'd)

INDEX OF STATIC STABILITY, DRAG AND PITCH DAMPING MEASUREMENTS

Figure	Configuration	Mach No.
30	$BLF^1 T_1^1$	0.85
31	BLT_1^1	1.75
32	$BLF^1 T_1^1$	1.75
33	BLT_2^1	0.23
34	$BLF^1 T_2^1$	0.23
35	BLT_1^2	0.23
36	BLT_2^2	0.23
37	$BLF^1 T_2^2$	0.23
38	$BLF^1 T_2^2$	0.23
39	BLT^3	0.79
40	$BLF^1 T^3$	0.79
41	$BLF^2 T^3$	0.79
	<u>Index of Drag Measurements</u>	
42	$B\text{-}T_1^1$	0.40-2.20
43	$B\text{-}T^3$	0.40-2.20
	<u>Index of Pitch Damping Measurements</u>	
44	$BLF^1 T^3$, BT^3, BT_2^3	0.22-0.70

TABLE 2

COMPARISON OF THE CENTER OF GRAVITY AND THE CENTER OF PRESSURE AMONG THE VARIOUS CONFIGURATIONS

Configuration	Body Length (calibers)	Mach Number	Center of Gravity from Nose (calibers)	Center of Pressure from Nose (calibers)
BLT^1_1	5.642	0.29	1.600	3.20
$BLF^1 T^1_1$	5.642	0.29	1.542	2.97
BT^1_1	5.642	0.59	1.644	3.19
BLT^1_1	5.642	0.59	1.600	3.20
$BF^1 T^1_1$	5.642	0.59	1.562	2.91
$BLF^1 T^1_1$	5.642	0.59	1.542	3.09
BLT^1_2	5.954	0.23	2.070	3.84
$BLF^1 T^1_2$	5.954	0.23	1.852	3.65
BLT^2_1	5.642	0.23	1.507	3.93
BLT^2_2	5.954	0.23	1.644	4.17
$BLF^1 T^2_2$	5.954	0.23	1.542	4.04
$BLF^1 T^3_3$	6.267	0.23	1.646	4.57
BLT^3	6.267	0.79	1.607	4.68
$BLF^1 T^3$	6.267	0.79	1.493	4.49
$BLF^2 T^3$	6.267	0.79	1.493	4.57

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1. ORIGINATING ACTIVITY (Corporate author) U. S. Naval Ordnance Laboratory White Oak, Silver Spring, Maryland	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b GROUP

3. REPORT TITLE

Wind Tunnel Investigation of the MK 76 Practice Bomb

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

NAVORD REPORT 6772 of 11 September 1964

5. AUTHOR(S) (Last name, first name, initial)

Regan, Frank J.

6. REPORT DATE	7a. TOTAL NO OF PAGES	7b. NO OF REFS
11 September 1964	14 (44 Fig.)	4

8a. CONTRACT OR GRANT NO. RMMO 42-005	9a. ORIGINATOR'S REPORT NUMBER(S) NAVORD6772
b. PROJECT NO.	
c	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d	ARR-79

10. AVAILABILITY/LIMITATION NOTICES

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY BUWEPS - RMMO

13. ABSTRACT

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DD FORM 1 JAN 64 1473

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14. KEY WORDS	LINK A		LINK B		LINK C	
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2. Bombs - Wind tunnel tests

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